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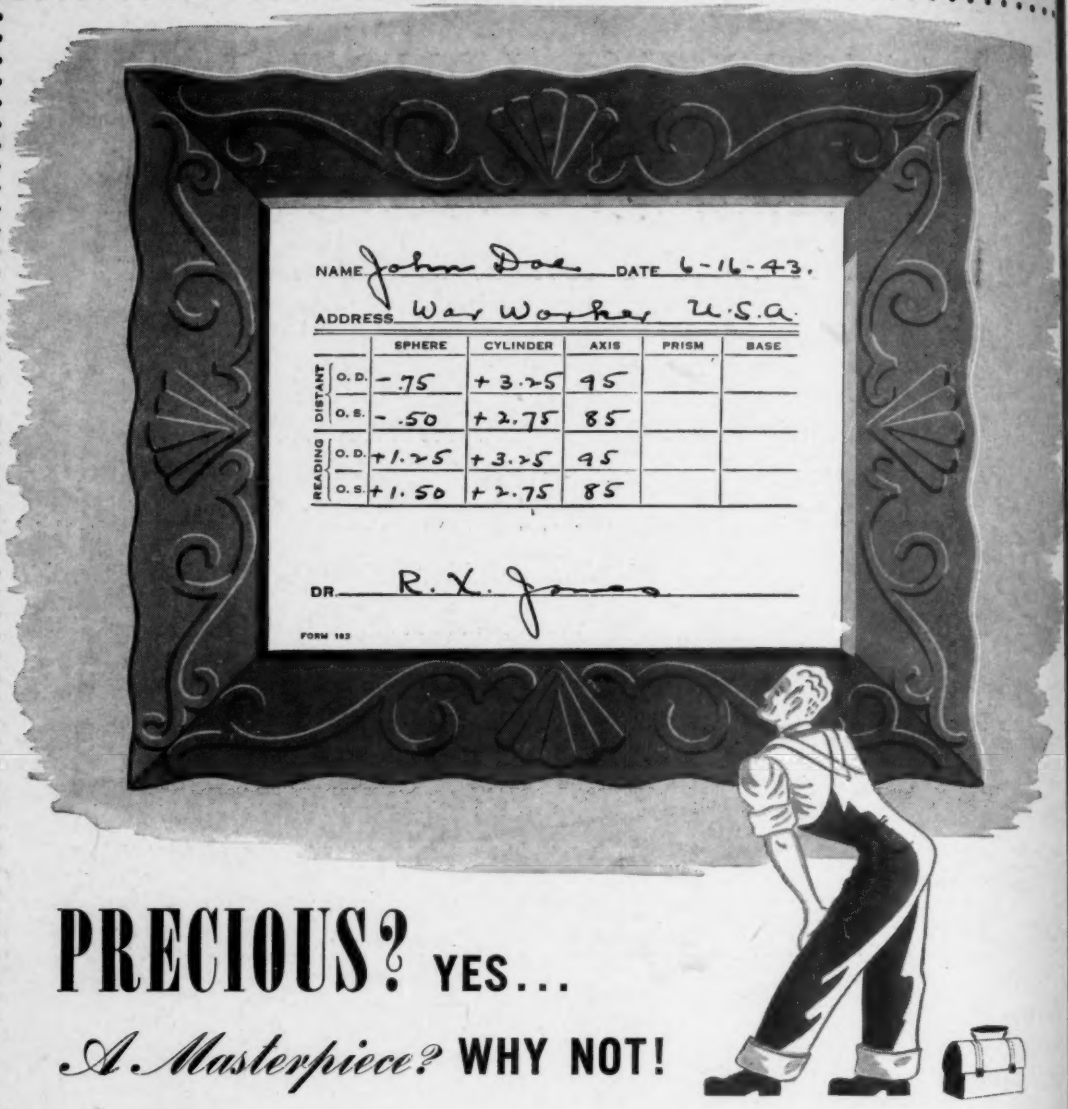
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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 26 JULY, 1943 NUMBER 7

DIATHERMY COAGULATION IN THE TREATMENT OF ANGIOMATOSIS RETINAE AND OF JUVENILE COATS'S DISEASE: REPORT OF TWO CASES*

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Weve[1] in 1939 first reported successful obliteration of the lesion in a case of angiomatosis retinae by diathermy. He used surface diathermy coagulation over the angiomatous mass and diathermy punctures with a small needle to close off the feeding vessels. The site of the angioma became a healed scar, the previously dilated vessels collapsed, and remote retinal and subretinal exudates disappeared. There was no recurrence of lesions during a two-and-a-half year follow-up period. Weve mentioned that a colleague of his, Professor Rochat, had independently treated another patient who had moderately advanced angiomatosis retinae in a similar manner and with an equally successful result. Kaye[2] in 1941 reported successful results in two patients operated on by Stallard. In both of these patients the lesions were early. A combination of electrolysis, surface diathermy, and diathermy punctures was used. The sites of the lesions became scars, the engorged vessels became normal in size, and there was no recurrence of retinal pathologic change during a 12-month follow-up period. Lewis[3] in 1942 published the first American report of angiomatosis retinae treated successfully with diathermy punctures. The large angioma was obliterated and its site became a scar, the dilated vessels collapsed, and the remote exudates disappeared. There was no recurrence of lesions during a follow-up period of one year.

The present report adds to the aforecited literature one case of bilateral angiomatosis retinae in which diathermy operations gave gratifying results, and one case of juvenile Coats's disease in which a diathermy operation has apparently checked this remorselessly progressive disease.

Case 1. Angiomatosis retinae (von Hippel's disease).

A. P., a white girl, aged 13 years, was aware of blurred vision in her left eye during October, 1941. Her mother and one brother had died of what was probably Lindau's disease. Her general health had always been excellent.

Examination of the patient's eyes on December 2, 1941, revealed early bilateral angiomatosis retinae. The right eye was entirely normal except for one greatly dilated retinal artery and vein leading into and from a pinkish mass in the upper nasal periphery, about 2 disc diameters in size and projecting forward

*From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

about 6 diopters. Corrected vision of the right eye was 20/15−2. The left eye showed several greatly dilated retinal vessels extending temporally, and an angiomatous mass in the upper temporal periphery and another in the lower temporal periphery. There was early glial proliferation, with a small retinal hemorrhage in the temporal periphery. Corrected vision of the left eye was 20/20 −2.

The patient was first given 1,500 r of X-ray therapy in divided doses to each eye; 200 K.V. with a 1-mm. copper filter was used, and a small aperture to avoid irradiating the lenses. In spite of this therapy the angiomatous mass in the right eye became slightly larger and in the left eye it steadily progressed into massive glial formation and retinal detachment. On June 19, 1942, corrected vision in the right eye was still 20/15 −2, but in the left eye vision had been reduced to 1/200. Fundus pictures of this date are shown in figures 1 to 4.

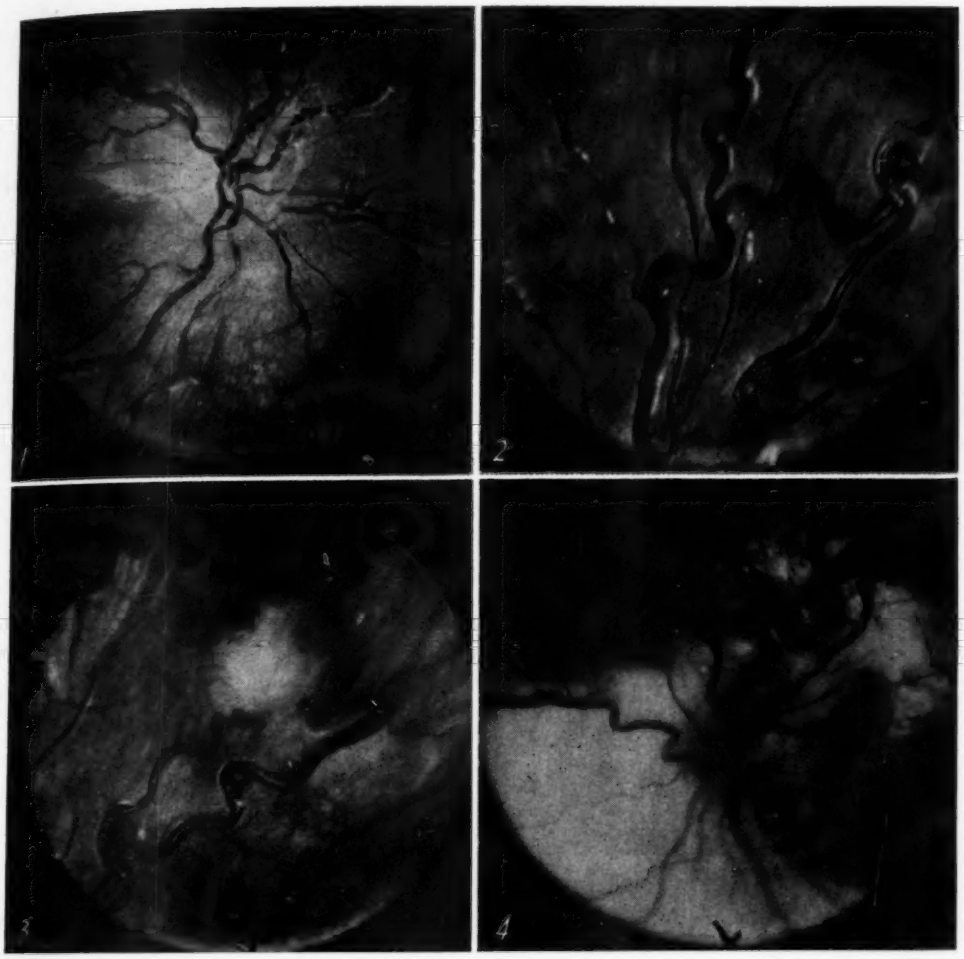
On June 20, 1942, bilateral diathermy operations were performed. The operative procedures and the subsequent course for each eye are given separately:

Right eye. The single angioma in this eye was localized by shining an ophthalmoscope light on the lesion. The point where the light penetrated the sclera was marked. Sixteen Walker pins were then inserted, as in a detachment operation, into and just surrounding the tumor mass, their positions being confirmed by frequent ophthalmoscopic examinations. A current of approximately 15 milliamperes was applied for 3 seconds through each pin. A small hemorrhage appeared within the tumor during this procedure. No attempt was made to close off the nutrient vessels, and at the close of the operation the vessels appeared almost as large as before, although the angiomatous mass had been completely obliterated.

Postoperatively the fundus of the right eye showed a marked reaction. There was a moderate-sized hemorrhage surrounding the obliterated angioma and in the overlying vitreous, a good deal of subretinal serous exudate producing a flat detachment of the entire upper half of the retina, and some subretinal hemorrhage around the temporal side of the disc. Within the first week after the operation the retinal vessels gradually decreased in size until they were normal. Three weeks after the operation the fundus picture was as is shown in figures 5 and 6, and corrected vision was 20/50−1. The reaction slowly but completely subsided. Six weeks after the operation all hemorrhage and exudate had disappeared, the site of the angioma was a healed scar, the vessels were still normal in size, and corrected vision had returned to 20/15−2. Fundus pictures, taken five months after the operation, are shown in figures 7, 8, and 9. The patient was last seen on January 4, 1943. At this time, seven months after the operation, no further change had occurred in the eye.

Left eye. In the left eye the tremendous gliosis and subretinal exudate of the entire temporal fundus obscured the angiomatous masses. Surface diathermy was therefore applied over the entire temporal half of the sclera extending back to within 4 mm. of the macula. At the end of this procedure the tension in the eye was increased and the cornea steamy. Three scleral punctures were made with Walker pins, but no subretinal fluid escaped.

Postoperatively the fundus of the left eye showed an increase in the retinal and subretinal exudate. The lower temporal vessels appeared to be smaller, but the upper temporal vessels were un-



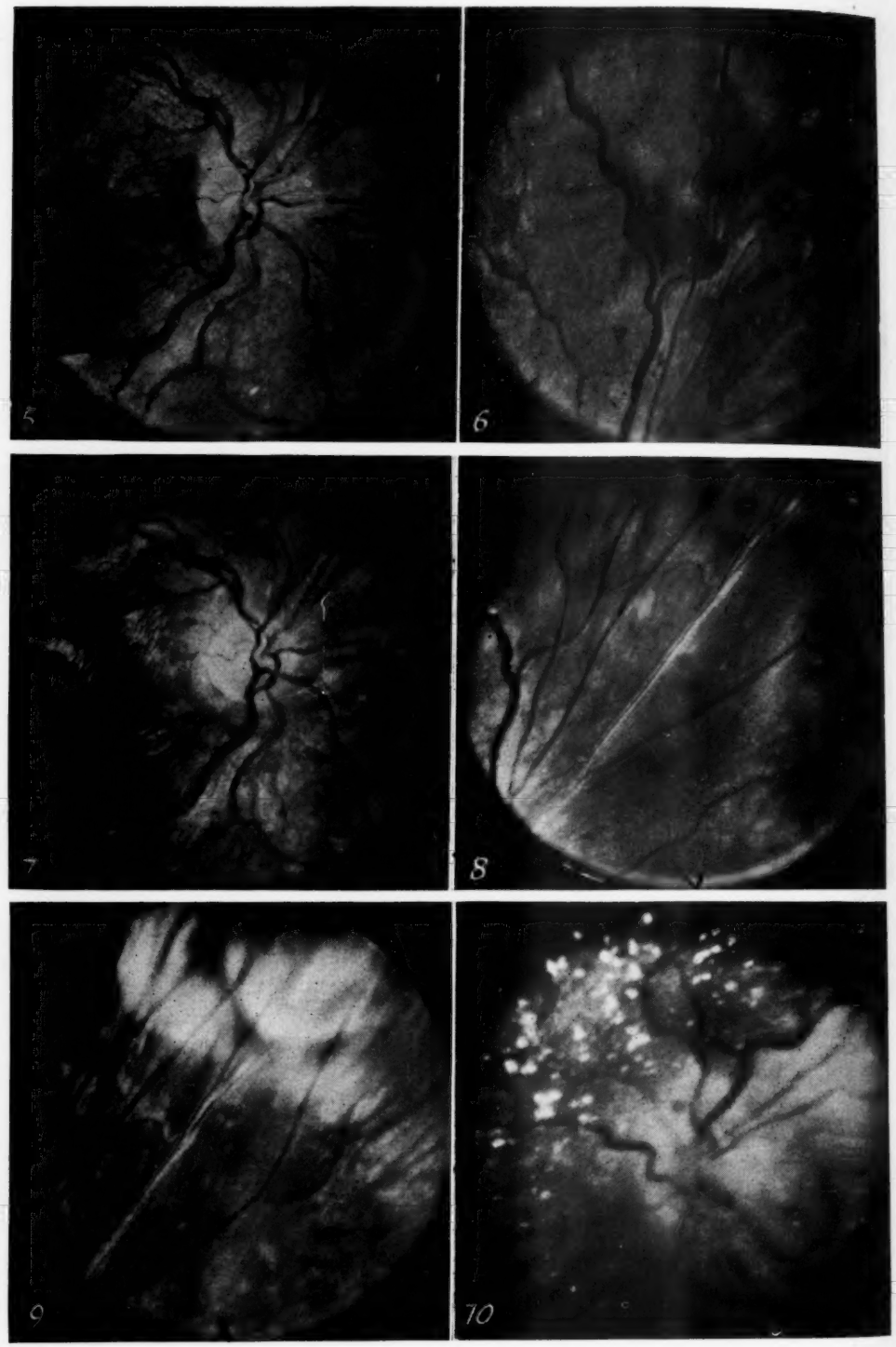
Figs. 1 to 4 (Guyton and McGovern). Case 1.

Figs. 1, 2, and 3 are fundus photographs of the right eye taken on June 20, 1942 (immediately preceding operation).

Fig. 4 is a fundus photograph of the left eye taken on June 20, 1942.

changed. During the following six weeks the detachment decreased and fundus details became much clearer than before the operation. On the nasal side the retina was still completely detached, but in the temporal and lower temporal peripheries it was flat and adherent to the choroid. There was one large dilated vein and artery feeding two connected angiomatous masses at the 1:00-o'clock position.

On September 5, 1942, these two angiomatous tumors were obliterated. A procedure similar to that previously used on the right eye was carried out, 15 Walker pins being used. Postoperatively there was again very marked reaction, but during the following two months the media cleared markedly and fundus details could be seen better than ever (fig. 10). The upper, nasal, and lower portions of the retina were still detached, but the retinal vessels were smaller, and the retinal and subretinal exudation was



Figs. 5-10. See opposite page for legend.

less extensive. The detached retina had begun to look atrophic, there were numerous sharply circumscribed glistening white spots in it, and vision was still reduced to 1/200. A small angioma was visible in the far periphery at the 6-o'clock position and another small angioma in the detached portion of retina at 12 o'clock. On November 9, 1942, these two angiomata were obliterated. Walker pins were inserted in the angioma at 6 o'clock, but it was necessary to use a longer needle to reach the angioma in the detached portion of retina at 12 o'clock. Again there was marked postoperative reaction, which slowly subsided. On January 4, 1943, the retina was still detached and vision was only 2/200, but no angiomata nor dilated vessels were visible, and almost all retinal exudate had disappeared. The eye has, of course, no chance of regaining useful vision, but it is hoped that obliteration of the angiomata will save it from eventual enucleation.

Case 2. Exudative retinitis (juvenile Coats's disease).

E. S., a white girl, aged 7 years, developed progressive failure of vision in her left eye during the summer of 1941. The eye was neither painful nor inflamed at any time. Family history was noncontributory. Her general health was excellent and her only illnesses had been whooping cough in January, 1941, and chicken pox in June, 1941.

Examination of the patient's eyes by Dr. F. M. Reese, on September 2, 1941, revealed bilateral exudative retinitis (Coats's disease). Vision of the right eye was 20/20. Except for the fundus, this eye was entirely normal. The disc was slightly grayish in color and definitely blurred. In the far temporal periphery was an area of grayish-white exudate about 2 disc diameters in extent. The vessels over this area were small but showed sharp and irregular changes in direction as if affected by a local elevation of the retina. Vision in the left eye was no light perception. In this eye there were complete detachment of the retina with massive exudation and gliosis, and a large retinal and vitreous hemorrhage in the lower temporal quadrant. The anterior segment was normal except for a mildly positive aqueous ray. Tension was slightly soft to fingers.

Nothing of significance was revealed by a complete diagnostic survey which included general physical examination, blood Wassermann test, hemocytologic examination, urine and stool examinations, X-ray films of orbits and skull, complete blood chemistry, intracutaneous tuberculin tests, spinal-fluid examination, and serologic tests for brucellosis, typhoid, dysentery, tularemia, and toxoplasmosis.

The subsequent course for each eye is given separately:

Left eye. On March 7, 1942, the patient contracted measles. On the same date the left eye developed glaucoma and became painful, but this subsided spontaneously in five days. The left eye then became phthisical and was enucleated on May 29, 1942. Histologic examination showed in the periphery of the

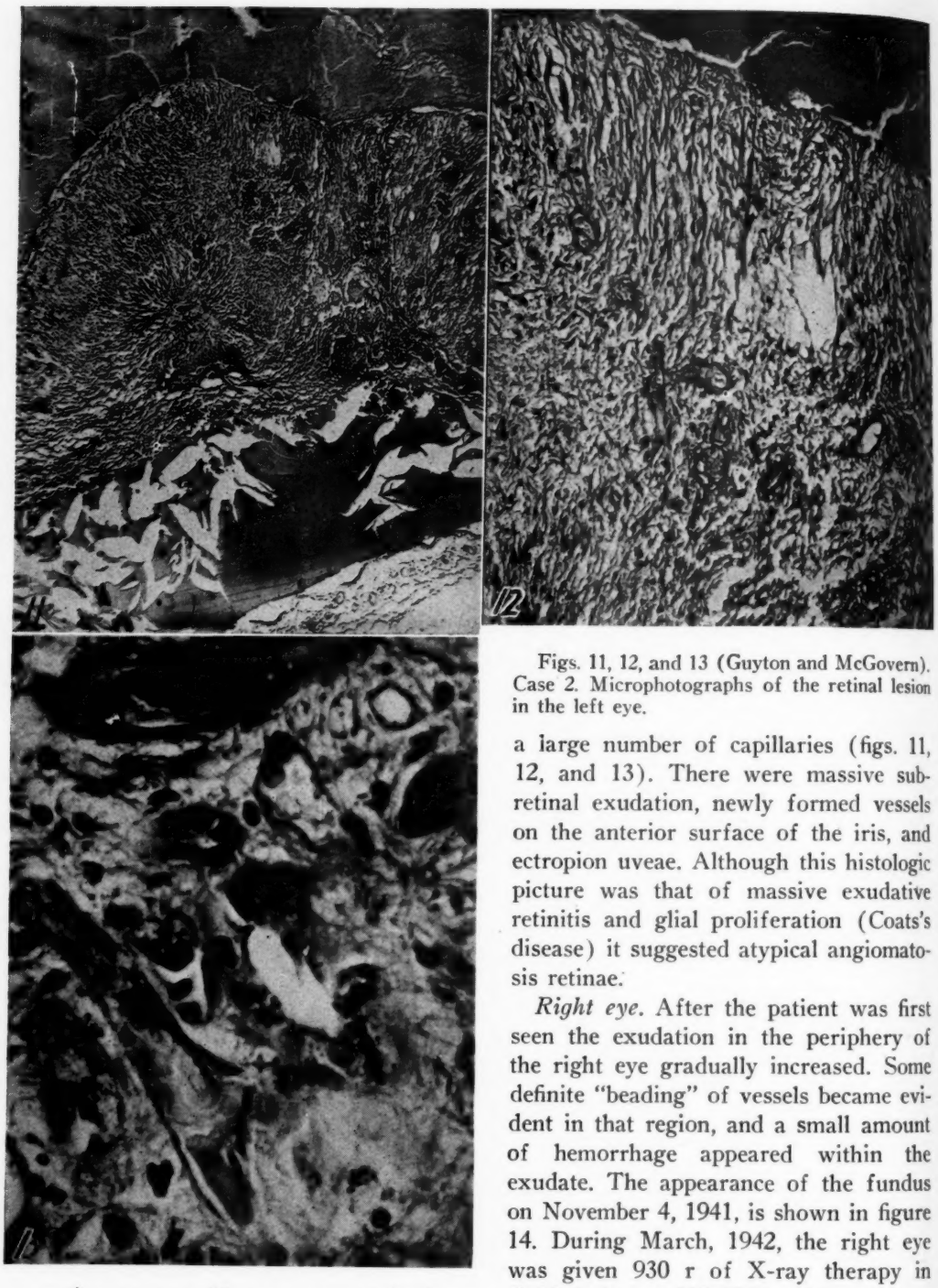
←

Figs. 5 to 10 (Guyton and McGovern). Case 1.

Figs. 5 and 6 are fundus photographs of the right eye taken on July 13, 1942 (three weeks after the operation).

Figs. 7, 8, and 9 are fundus photographs of the right eye taken on November 9, 1942 (five months after the operation).

Fig. 10 is a fundus photograph of the left eye taken on November 9, 1942 (two months after the second operation).



Figs. 11, 12, and 13 (Guyton and McGovern). Case 2. Microphotographs of the retinal lesion in the left eye.

retina on one side some unusually large blood vessels associated with an area of massive glial proliferation, and in places a large number of capillaries (figs. 11, 12, and 13). There were massive subretinal exudation, newly formed vessels on the anterior surface of the iris, and ectropion uveae. Although this histologic picture was that of massive exudative retinitis and glial proliferation (Coats's disease) it suggested atypical angiomatosis retinae.

Right eye. After the patient was first seen the exudation in the periphery of the right eye gradually increased. Some definite "beading" of vessels became evident in that region, and a small amount of hemorrhage appeared within the exudate. The appearance of the fundus on November 4, 1941, is shown in figure 14. During March, 1942, the right eye was given 930 r of X-ray therapy in divided doses; 200 K.V. with a 2-mm. copper and 1-mm. aluminum filter was used, and a small aperture to avoid irra-

diating the lens. In spite of this therapy the area of exudation gradually but steadily increased in size, the disc became much more edematous, and a hazy spot of subretinal exudation began to form just below the disc.

The right eye was operated upon on August 1, 1942. The external rectus was cut and the temporal sclera exposed. Sixteen Walker pins were inserted as in a standard detachment operation, with the aid of frequent ophthalmoscopic examinations. The area of exudation in the temporal periphery was completely obliterated and surrounded by these diathermy punctures. During the first week after operation there was surprisingly little reaction in the fundus. On August 12, 1942 (11 days after the operation), corrected vision was still 20/20−3. Extending from the 7 to the 10 o'clock position, in the temporal periphery, was an elevated white area in which there was some blood undergoing absorption. The disc was slightly more edematous, and the subretinal exudate below the disc was slightly more prominent than before the operation. Four weeks after the operation the fundus reaction reached its height, with more edema of the disc, extending out into the macular region. At this time vision with a pinhole was reduced to 20/70. During the succeeding four weeks the area in the periphery that had been treated with diathermy punctures contracted down into a white scar with a pigmented border. The edema of the macula and about the disc disappeared, the subretinal exudation just below the disc became absorbed, and corrected vision returned to 20/20—3. Figure 15 shows the appearance of the fundus eight weeks after the operation. The fundus appearance and vision were unchanged when the patient was last seen, on January 4, 1943.

Comment

The results of radium or X-ray therapy for angiomatosis retinae have at best been uncertain.[4] The success of diathermy obliteration, as exemplified by this and previous reports, indicates that diathermy should be more widely used for this condition. The exact technique of the diathermy operation probably does not matter, so long as each angiomatous mass is completely obliterated. In the case here reported the engorged vessels collapsed even though they were not directly obliterated at the time of the operation. Probably less postoperative subretinal reaction would have resulted had fewer punctures been made, and light surface coagulation may be all that is necessary. It is important to note that retinal and subretinal exudates remote from the lesion became absorbed after the primary angioma was eradicated.

The causes of Coats's disease are not known, but there are certainly at least two types. One type usually begins in elderly individuals and in its early stages resembles or is the same as retinitis circinata. The other type occurs in younger patients, and in its course simulates angiomatosis retinae except for the absence of a circumscribed angiomatous mass and dilated retinal vessels. In both types there is probably some form of vascular lesion, with secondary hemorrhage, exudation, and gliosis. After a careful pathologic study of four eyes with juvenile Coats's disease Berg[5] concluded that the primary process is the same as, or at least very similar to, angiomatosis retinae. He decided that the differences in clinical appearance depend on the extent and development of the same type of primary vascular lesion. In the enucleated eye of the case reported here the small areas of capillary proliferation and the dilated vessels on the surface of the retina suggested a

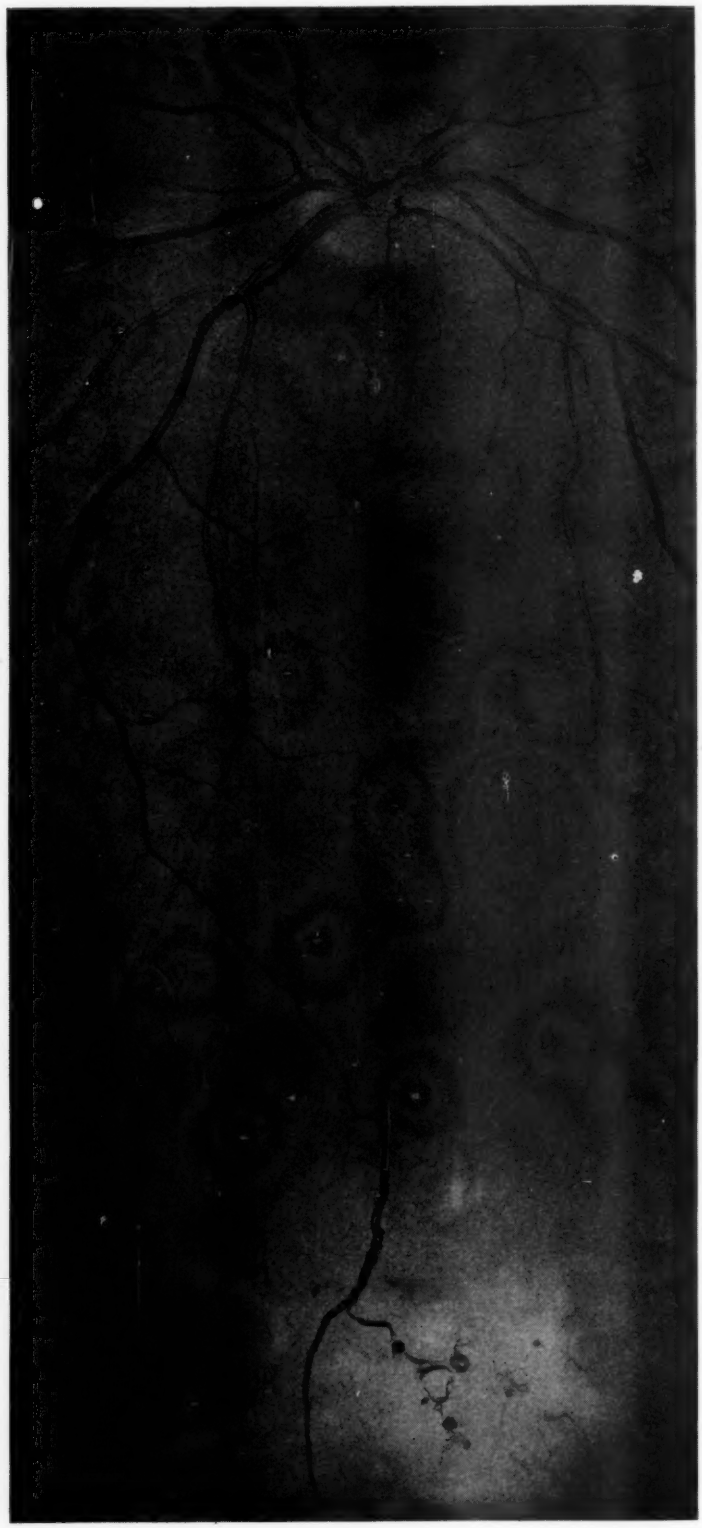


Fig. 14 (Guyton and McGovern). Case 2. The fundus of the right eye as it appeared on November 4, 1941.

Fig. 15 (Guyton and McGovern). Case 2. The fundus of the right eye as it appeared on October 4, 1942 (two months after the operation).

lesion at least similar to angiomatosis, and the beading of the vessels in the lesion of the eye treated with diathermy punctures was also suggestive.

Heretofore no treatment of Coats's disease has yielded good results. The apparent success of diathermy punctures in this case is consequently of great importance. Hitherto this type of retinal lesion has inevitably led to loss of vision. Whatever may be the primary cause of the lesion, the observations here reported indicate that obliteration with diathermy at least offers a chance of saving vision. It is significant that in this patient eradication of the primary lesion in the periphery of the retina caused subsidence of the edema of the disc and the subretinal exudation below the disc.

Summary

In a patient with early angiomatosis retinae of the right eye and advanced angiomatosis retinae of the left eye, the angiomatous masses were obliterated by diathermy coagulation. The sites of the angiomatous masses became scars and the dilated retinal vessels were reduced in size. Vision was completely preserved in the right eye; the ophthalmoscopic appearance of the left eye improved, although vision was not regained in this eye.

In a patient with early juvenile Coats's disease of the right eye and complete blindness of the left eye from massive exudative retinitis, the left eye was enucleated because of early phthisis. Histologic examination of this eye showed a few areas of capillary proliferation in the retinal lesions somewhat suggestive of angiomatosis retinae. The primary peripheral retinal lesion in the right eye, which had steadily progressed in size for 11 months, was obliterated with diathermy punctures. The site of the peripheral lesion became a scar, edema of the disc and a subretinal exudate below the disc disappeared, and vision was completely preserved.

Wilmer Ophthalmological Institute.
1100 Main Street.

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A COLORED REFLEX FROM THE ANTERIOR CAPSULE OF THE LENS WHICH OCCURS IN MERCURIALISM

WALTER S. ATKINSON
Watertown, New York

The purpose of this communication is to report the observation of a brownish-colored reflex from the anterior capsule of the lens which occurs in cases of chronic mercurialism. This reflex may be found also in those who have worked for a long time with mercury or in an atmosphere containing mercury, although they may exhibit no symptoms of mercurialism. The reflex has not been observed in other patients, nor has any previous report of such a reflex been found in the literature.

This lusterless, somewhat homogeneous looking reflex from the anterior capsule of the lens is seen well with the slitlamp, when a low-power objective is used (fig. 1). The color of the reflex is deeper in the pupillary area, and in different individuals its color varies from a light brownish gray to a deep rose brown. The depth of color apparently depends somewhat upon the length of time and the amount of mercury to which the individual has been exposed. Small, round, punched-out defects and cracks often appear in the reflex. These resemble the behavior of metallic mercury. Glass lenses which have been exposed to mercury vapor present a similar brown reflex when examined with the slitlamp.

When examined with oblique illumination, the lenses of eyes in which the colored reflex is marked present a dull-gray appearance (fig. 2). This grayish appearance is denser in the pupillary area, and one would expect to find the lenses quite hazy when examined with the ophthalmoscope. On the contrary, they appear to be perfectly clear. Furthermore, the apparent haziness of the anterior capsule and the colored reflex do not interfere with vision. Those in whom this reflex was most pronounced had normal vision or better.

The colored reflex, which is believed to be a deposit of mercury on or in the anterior capsule, does not disappear after the symptoms of chronic mercurialism subside nor when the individual discontinues work with mercury. Some patients were examined 10 and 20 years after they had last worked with mercury, and the reflex was still as vivid as that which is seen in active workers who have symptoms of chronic mercurialism.

In nine of those examined, three of whom had symptoms of mercurialism, a faint, similarly colored reflex was observed from the anterior adult nuclear zone. In two of these patients there was a light-brown reflex from both the anterior capsule and the adult nuclear zone. In one it was observed from the anterior capsule in the right eye and from the anterior adult nuclear zone in the left eye. No similar reflex was observed from the posterior cortex or the posterior capsule. Moreover, no other ocular lesions that could be attributed to the effect of mercury were observed. The colored reflex was not seen in the cornea, nor were any endothelial changes observed.

Seventy persons who are or had been engaged in the manufacture of thermometers in which mercury is used were examined.

One patient who had worked as a coner in the felt-hat industry for over 30 years was also examined. This man exhibited marked symptoms of chronic mercurialism and a pronounced colored reflex from the anterior capsule.

The colored reflex was present in 37,

or over one half of the cases examined.

Fourteen of the 71 manifested symptoms of chronic mercurialism, and in all of these cases the reflex was present.

All but one of the 37 individuals exhibiting the colored reflex had been in close contact with mercury for five years or more. The one exception was a man who had worked with mercury for only three and one half to four years. Eighteen of the 37 had been engaged in this work for over 20 years and 10 for over 30 years. It evidently requires considerable time for the colored reflex in the lens to develop, and if the individual is sensitive to mercury, certain symptoms of mercurialism may appear.

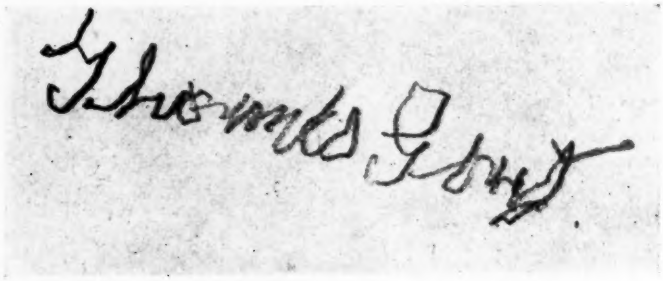

Fig. 3 (Atkinson). Signature showing intention tremor.

One might say, therefore, that the mercury reflex may quite consistently be found in cases of chronic mercurialism and in those who have been exposed to mercury for a prolonged period of time. However, all individuals in whom the reflex was present did not exhibit symptoms of chronic mercurialism. The explanation of this may lie in the fact that some persons are more sensitive to mercury than others, or that the reflex develops before other symptoms of mercurialism manifest themselves.

The fact that the reflex occurs more frequently than do the usual symptoms of mercurial poisoning would suggest that such a reflex is an indication that a mercury hazard is present. In this case the hazard could be eliminated before serious symptoms occur.

A thorough general physical examination was not made in every case. Only the more frequently observed and obvious symptoms of mercurialism, such as tremor, exaggerated patellar reflex, pallor, odor and the effect upon the teeth and gums were looked for. Those examined were also questioned regarding loss of weight, fatigue, irritability, and gastric disturbances.

The following symptoms of chronic mercurialism were most frequently observed: an intention tremor was present in all those classed as having symptoms of chronic mercurialism (fig. 3). The tremor was fine in most cases, but coarse in a few. The hands, head, or both, were the parts affected. In seven of the cases the patellar reflex was exaggerated.

The second most frequent symptom was the effect upon the teeth and gums; this was present in nine (fig. 4). There was gingivitis, the gums being swollen, red, and spongy. The teeth were carious and loose, with bone destruction or absorption, and in some cases many or all the teeth had been extracted.

A slight gray gum line, often regarded as a symptom of chronic mercurialism, was observed in only four, whereas the mercury reflex from the anterior capsule was present in all those who displayed symptoms of mercurialism.

Pallor of the skin was noted in 3 of the 14 patients with symptoms of chronic mercurialism, and in 4 the skin of the face presented a gray appearance, as if mercury had been rubbed into it.

All those examined who were then working with mercury had a char-

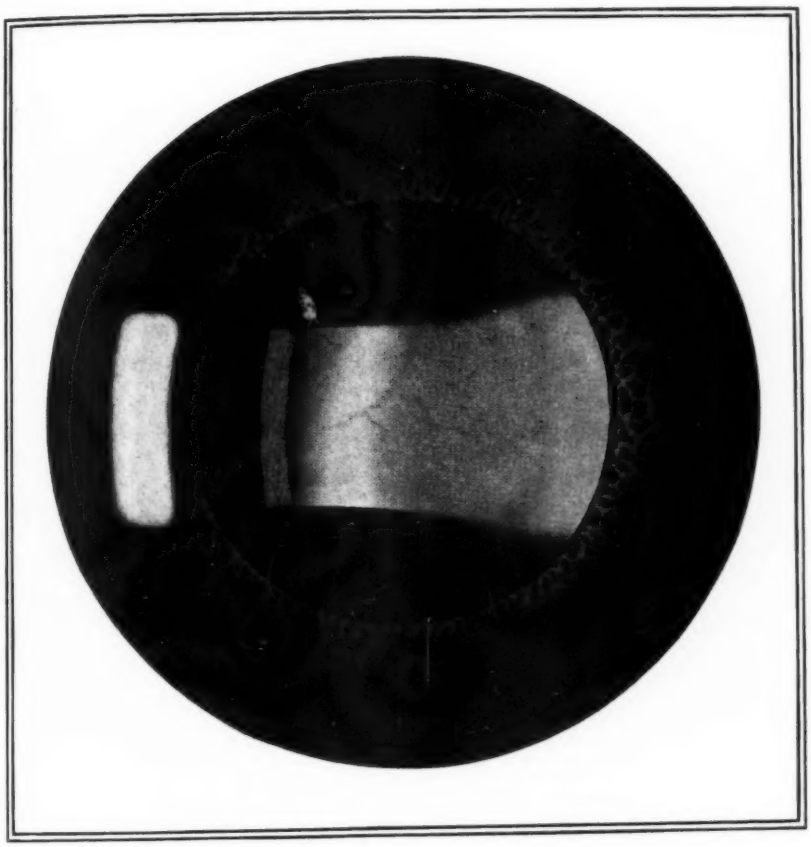

FIG. 1 (ATKINSON). DRAWING OF THE SLITLAMP BEAM SHOWING A ROSE-BROWN REFLEX FROM THE ANTERIOR CAPSULE OF THE LENS.

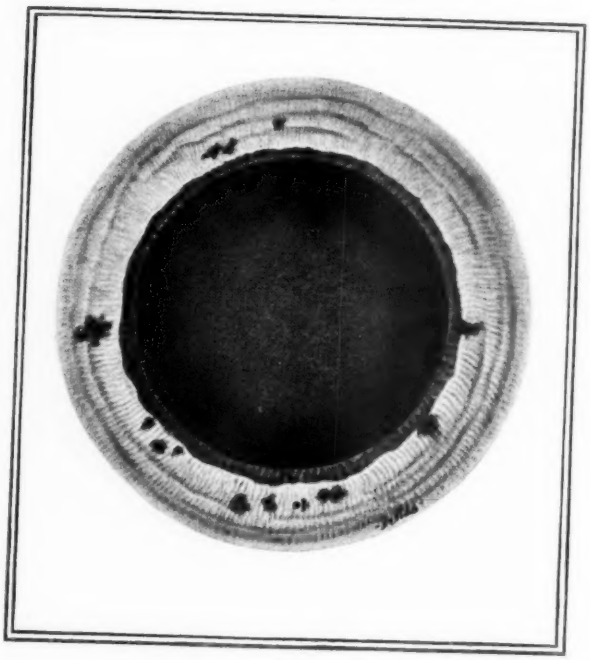

FIG. 2 (ATKINSON). DRAWING TO SHOW THE GRAY REFLEX OF THE LENS ON OBLIQUE ILLUMINATION

acteristic odor similar to that of patients who have been receiving mercury inunctions. This may come from their clothes, but its presence should warn one to be on the alert for other evidences of mercury poisoning.

The colored reflex and tremor were the most constant sign and symptom of chronic mercurialism, and were present in all who were regarded as having symptoms of mercury poisoning.

Apparently mercurialism is not uncommon. In a study of the fur-cutting industry conducted by the United States Public Health Service,[1] 43 cases of mercurialism were found. Neal and others,[2] following a recent study of the felt-hat industry, reported 59 cases of mercurialism with symptoms similar to those found in the fur cutters. Mercuric nitrate, used in carroting the fur, was considered responsible. To prevent poisoning, the mercury is now being replaced by a nontoxic carroting agent, and no doubt fewer cases will be observed as a result.

Eight of the 14 patients who exhibited symptoms of mercury poisoning had previously been examined or refracted by me; but in the course of these examinations the symptoms of mercurialism were recognized in only two. During these earlier examinations the mercury reflex was noted in only one, and its significance was not appreciated.

Although most of the persons in this group had consulted their general physician, or in some instances several physicians, the diagnosis of mercury poisoning was made in only three instances.

A

B

C

Fig. 4 (Atkinson). X-ray films showing the effect on the teeth and bone.

Several dentists also failed to associate mercurialism with the gingivitis, pyorrhea, dental caries, and bone destruction.

My purpose in calling attention to these errors or lack of proper diagnosis is to emphasize how easy it is to overlook or misinterpret the symptoms of mercury poisoning.

Conclusion

The colored reflex from the lens is suggested as a permanent and probably an early diagnostic sign of chronic mercurialism.

129 Clinton Street.

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MULTIPLE PRIMARY MALIGNANT NEOPLASMS*

Report of a case of malignant melanoma of the choroid and glioblastoma multiforme of the right cerebral hemisphere

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Although the incidence of multiple primary malignant tumors is small when expressed in percentage, the list of reported cases is long. Recent literature contains very few references to the subject, but a decade or two ago it was frequently discussed by pathologists, and several extensive statistical reviews were published. These established the uniqueness of the case to be reported, in which one eye was removed because of malignant melanoma of the choroid, and four years later the patient died of glioblastoma multiforme of the cerebrum.

The publications of Major (1918),[1] Owen (1921),[2] Warren and Gates (1932),[3] Hurt and Broders (1933),[4] and Schreiner and Wehr (1934)[5] cover more than 1,500 cases. These are divided into groups according to the type and location of the tumors. In the reported cases multiple primary malignant neoplasms occurred most commonly in the same organ, or in organs of the same system. By far the largest group is composed of multiple skin carcinomata. Basal-cell epitheliomata of the skin are especially likely to be multiple, and according to Ewing[6] this characteristic is an expression of multicentric growth. It would seem logical not to include multicentric growths in the same category with cases in which multiple unrelated tumors were found. Among the group in which miscellaneous malignant neoplasms were encountered in different organs there were four instances of ocular tumors. Cerebral neoplasms were about as rare as ocular ones, and in all the reports examined, there was no instance of the combination of primary malignant tumors in eye and in brain.

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Case history

J. W., a white man, aged 26 years, married, first consulted one of us (D. V.)

in February, 1933, because of blurred vision of the right eye, of five days' duration. Vision, O.D., was 20/25−; O.S., 20/20. Both eyes were free from congestion, the pupils were equal, the responses normal. The periphery of the fundus of the right eye appeared to be normal, but there was some edema in the macular region. An oval yellow spot was seen adjoining the inferior temporal vein and artery just below the macula. The left eyeground was normal. A diagnosis of beginning choroiditis, right eye, was made.

General physical and serologic examinations were not significant. The patient had suffered for years from migraine accompanied by ocular manifestations. He also had a congenital cardiac lesion which produced no symptoms and did not limit his activity. A first molar tooth was extracted.

A relative central scotoma was present in the field of the right eye. During the next few weeks the vision in this eye decreased to 20/40, but the fundus picture did not change materially. Then the edema in the macular region gradually subsided and vision improved to 20/30. At this time mention was first made of a slate-colored raised spot below the superior temporal vein. The possibility that the pigmented elevation was neoplastic was considered. Three months later there had been no change in its appearance, and it was decided that the slate-colored area was a congenital nevus. Two years later (May, 1935) it was noted that the elevation of this pigmented area was about 1½D. Vision, O.D., was 20/30. The left eye was normal; vision 20/20.

In the fall of 1936, the patient had several convulsive seizures, each followed by a period of confusion, but all were without neurologic residual signs. Vision in the right eye had decreased to 20/70, and the pigmented elevation had increased in size and encircled two thirds of the optic disc. There was no sign of papilledema nor other evidence of increased intracranial pressure. Two weeks later vision had been reduced to 20/200. The slate-colored area was roughly four or five times the size of the optic disc and elevated three diopters. It lay beneath the superior temporal retinal vessels, extended to the disc margin, and spread out fan-like around its superior and temporal borders. Retrobulbar transillumination through a conjunctival opening was undertaken. A definite shadow was seen above and on the temporal side of the optic disc. A diagnosis of malignant melanoma of the choroid was made, and it was thought that the convulsions might be due to cerebral metastasis.

The patient was sent to Dr. Dunnington for consultation and was also seen by Dr. Wheeler and Dr. Reese. All agreed that the right eye should be enucleated, and that a small pigmented nevus on the left forearm be excised.

Pathologic report. The small tumor removed from the forearm proved to be a collection of nevus cells.

The enucleated eye was fixed in 10-percent formalin. It was normal in size and in shape. When opened the vitreous was clear, the lens and retina were in place, except where the latter was elevated by the thickened choroid.

Microscopic examination. Except for congenital variations the anterior segment of the eye was normal.

In the posterior segment the choroidal lesion was seen as an elliptical thickening near the posterior pole, 2 mm. in width at its crest, and 8 mm. in extent. Near the center there was a heavily pigmented core 1½ mm. wide. The rest of the tumor was moderately pigmented (fig. 1). There was a cystic space in the black core containing macrophages loaded with melanin granules. The retina cover-

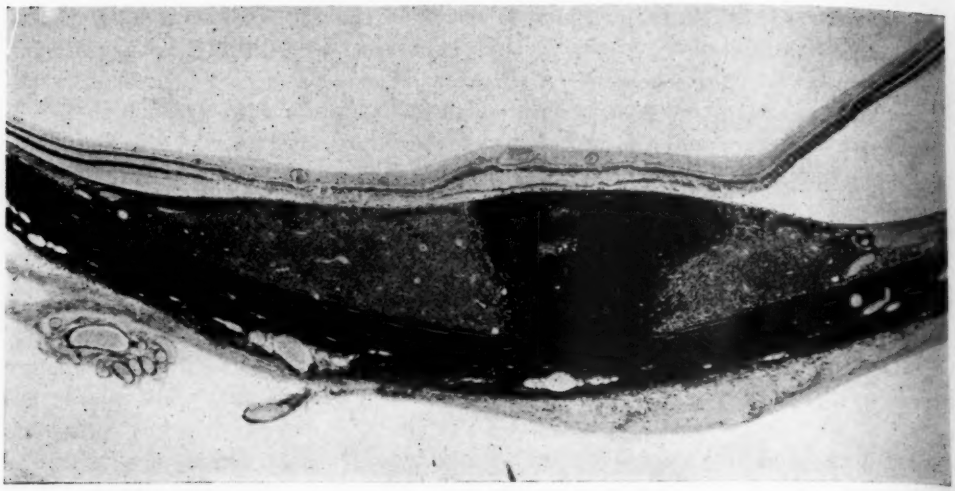

Fig. 1 (Asbury and Vail). Tumor in choroid, showing heavily pigmented core (×15).

ing the tumor showed degenerative changes, dilation of the vessels, and edema of the internuclear layer. The retinal changes began at the margin of the tumor on the nasal side, but extended beyond it on the temporal side, where the retina was detached by fluid. The tumor extended more than half way around the optic nerve, but neoplastic growth was confined to the choroid and had not invaded the optic nerve nor the subdural space.

The choroidal tumor was very cellular and only moderately vascular, most of the vessels present belonging to the preëxisting choroidal circulation. The tumor cells varied in size, but the majority were spindle shaped, having oval nuclei with conspicuous nucleoli (fig. 2). Only an occasional mitotic figure could be found. Many of the tumor cells contained melanin granules. Argyrophil fibrils were uniformly distributed throughout the tumor (fig. 3).

Diagnosis. Malignant melanoma of the choroid.

The attacks of migraine ceased about the time that the epileptiform seizures began. Following enucleation, the patient's general condition remained about the same for several years. His general physical condition was good, but the convulsions continued, occurring about twice a month, usually during sleep. Drugs failed to control the seizures. Encephalography was undertaken twice, first in the spring of 1938, and again in the fall of 1939 (18 months later). The results of both studies were unsatisfactory, but at neither time was a gross abnormality demonstrated that could be attributed to an intracranial tumor. The diagnosis rested between intracranial neoplasm and migraine equivalent.

A few months later the convulsions had increased in frequency but decreased in severity, and were occurring during the day as well as at night. In April, 1940, the patient was admitted to the hospital because of severe headaches. He was drowsy, and left facial weakness was apparent. The optic nerve head of the left eye was slightly edematous, and one hemorrhage was seen at the disc margin along the superior temporal vessels. Diagnosis of a right hemispheral expanding lesion was made, and craniotomy performed. A cyst was encountered and emptied, and almost the entire right temporal lobe, which was the seat of an in-

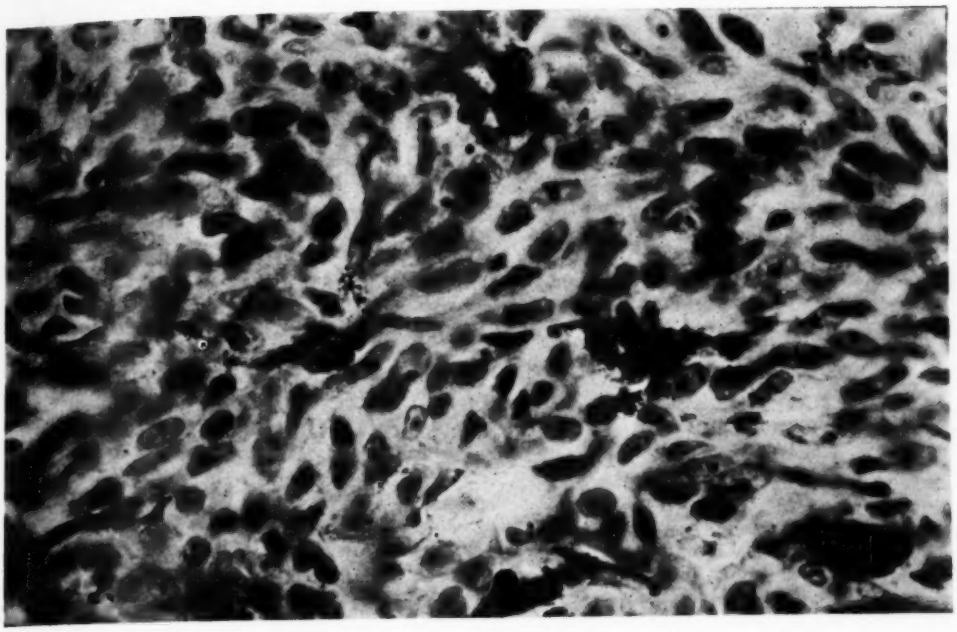

Fig. 2 (Asbury and Vail). Malignant melanoma of choroid (×650).

filtrating tumor, was exenterated. Microscopic study showed the neoplasm to be glioblastoma multiforme. Radiation therapy was administered. The patient was discharged from the hospital three weeks after operation in good condition. For nearly six months he carried on a normal life, was well adjusted to his surround-

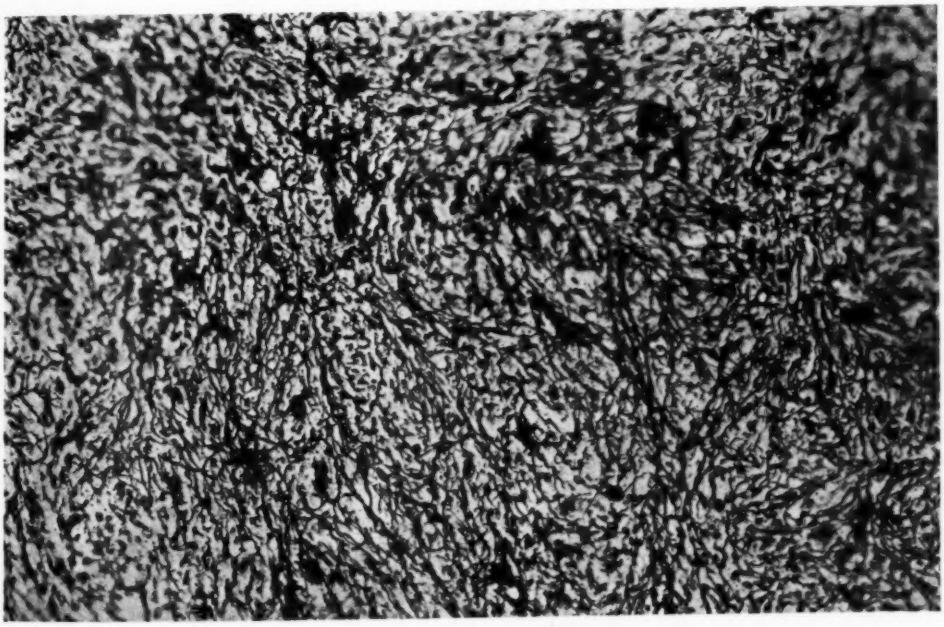

Fig. 3 (Asbury and Vail). Silver technique. Uniform distribution of argyrophil fibrils throughout choroidal neoplasm (×160).

ings, and transacted his business.

In November, 1940, headache recurred and was so severe that an attempt was made to evacuate the cyst again, but only two centimeters of fluid were obtained, and the patient was not relieved. Mentally he was clear and coöperative, but headache was constant and intolerable, vomiting ensued, and papilledema increased. Further operative intervention was deemed of no avail. The patient slowly grew emaciated, then passed into coma, and died two months later (January, 1941).

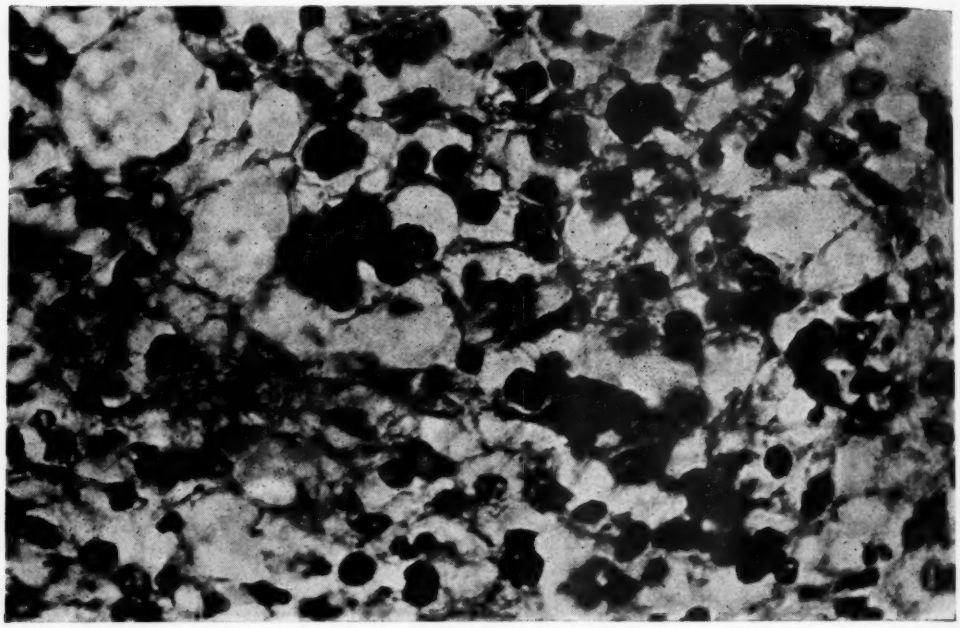

Fig. 4 (Asbury and Vail). Glioblastoma multiforme of cerebrum (×650).

At autopsy glioblastoma multiforme of the right cerebral hemisphere was found (fig. 4), and toxic and congestive changes in the viscera, but no evidence of metastatic lesions of malignant melanoma.

Discussion

At the onset of symptoms attributable to the tumors the patient was 29 years old, younger than the average age for ocular malignant melanoma, and much younger than the average age for multiple primary malignancy given in the aforementioned statistical reviews, in which it ranged from 50 to 62 years.

In reviewing the case it is apparent that the history of migraine merely confused the issue and had no real bearing on the pathologic findings. Since the convulsions began before the enucleation of the right eye, it is probable that the two tumors, one in the choroid, the other in the brain, were present at the same time. In the literature synchronous occurrence has not been insisted on as a criterion of multiple primary malignancy, nor have the rules laid down by Billroth, when he reported the first case in 1869, been followed. These have been modified so that multiple tumors of the same nature and occurring in the same organ (multicentric growths such as multiple carcinomata of the skin) might be included. However, our case fulfils Billroth's first two criteria,

namely that the tumors must differ histologically, and that they arise in different locations. The third tenet is not fulfilled, but the microscopic appearance of both tumors was so conclusive that the presence of metastases was not necessary for the confirmation of malignancy.

Much of the material reported on this subject has been gathered from autopsy reports. Our case might have been lost under such a system. Quite a different picture of the occurrence of multiple primary malignant tumors might have resulted if the multicentric growths had been excluded, and the material been collected by clinicians rather than pathologists.

All the studies of multiple primary malignant neoplasms emphasize the frequent occurrence of tumors in various organs of the same system. The eye and brain both belong to the central nervous system, and the present conception of malignant melanoma as a neuro-ectodermal tumor make it and glioma at least distantly related.

In summarizing their exhaustive study, Warren and Gates state that multiple primary malignant tumors occur more frequently than can be explained on the basis of chance; that a predisposing factor seems to be at work in certain individuals, but that the nature of the predisposition is unknown.

In the case reported here the malignant melanoma in the choroid apparently arose from a preëxisting nevus. Although such an origin for pigmented choroidal tumors has been suggested by a number of authors, the occurrence has rarely been observed and recorded. Wagener and Wellbrock[7] reported the first case in 1930. Mulock Houwer[8] studied a number of pigmented choroidal tumors and reported that the distribution of the pigment and the type and arrangement of the cells in many of them pointed to such an origin. Another Dutch investigator had found nevi in the uveal tract more frequently in 50 eyes containing malignant melanoma than in an equal control series.

Congenital uveal nevi are described as flat, slate-colored areas, usually about a disc diameter in size. In this case the plaque was described as elevated when first seen, and later that elevation was measured. This and the fact that the slate-colored area was not noted at the first examination may cast doubt on its being a true congenital nevus. However, the spot was quiescent under observation for several years, and its color and size fitted the classic description of nevus. The black core seen microscopically was thought to mark the site of the original slate-colored spot.

Summary

A case is reported presenting multiple primary malignant neoplasms, one an intraocular, malignant melanoma of the choroid, the other, which was the cause of death, glioblastoma multiforme of the cerebrum.

The choroidal neoplasm was seen to develop from a nevus that had been under observation for three years before it began to increase in size.

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THE OCULAR PATHOLOGY OF METHYL-ALCOHOL POISONING*

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INTRODUCTION

Methyl-alcohol poisoning in relation to the eye is of interest not only because it is clinically important, but also because the resulting pathologic processes in the eye are not fully known.

Whoever studies the literature on the subject must be impressed with the lack of uniformity of opinion as to the effects of methyl alcohol upon the ocular structures. Opinions concerning the toxicologic process are also at variance. Most of the opinions are based upon conclusions drawn from clinical observation, autopsy reports, and the results of experimental work in animals.

The literature is practically devoid of reports of studies upon pathologic specimens from the human eye. In most instances the reports were incomplete, and the material was not immediately fixed, thus allowing post-mortem degenerations to ensue. It is well known that the retina, even though refrigerated, immediately disintegrates, causing an appearance that may be interpreted as a pathologic change resulting from methyl alcohol. Another criticism of the early autopsy findings is that the fixing and staining process used was not adequate to show minute changes accurately. It seems, therefore, that whatever evidence may have been adduced as the result of human autopsy should be held in question.

Considering the ocular findings as the result of animal experimentations, doubt again arises. The fact impresses us that many of the conclusions reached concerning the effect of methyl alcohol on the human are based upon the results of experimental work on animals by H. Holden[1] in 1890 and Birch-Hirschfeld[2] in 1900. We must be skeptical of such conclusions, for Holden's work cannot be considered scientifically accurate. Likewise, Birch-Hirschfeld's work in 1900 should not be considered too seriously; he must have had some serious doubts as to its accuracy since he repeated it in 1920.[3] Doubt of the accuracy of the positive findings in this animal experimentation is also strengthened by the critical work of de Schweinitz,[4] who was unable to reproduce their results. Jonas Friedenwald[5] likewise obtained negative results and concluded, like de Schweinitz, that the previous work was probably in error. That such an error is possible is evident when we consider how very rapidly post-mortem changes occur in the retina. Also we must consider artifact and defective staining technique. It is entirely possible that the negative findings of de Schweinitz and Friedenwald are correct, and that animal experimentation is of no value in solving the problem. It is well known that animal tissues do not always exhibit the toxic effects of drugs that are manifested in the tissues of the human body.

The pathologic effect of methyl alcohol on the human being should be considered not only as to its effect upon the eye but also on the whole body, since its effect is widespread and not confined to a specific action on the retina, as some authors would have us believe.

Because of the uncertainty which apparently exists concerning these questions, further study of the subject seems

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indicated. The following investigation was undertaken to obtain more concrete information and thus establish a more definite conception of the ocular changes that are present in these cases.

Toxicity of methyl alcohol

The cause of the peculiarities of methyl-alcohol poisoning has not been satisfactorily explained. There is a paucity of facts regarding the actual behavior of methyl alcohol in the animal organism, so that the underlying causes of its extreme toxicity are by no means clearly understood. Certain facts, however, have been determined by animal experimentation and clinical observations which aid materially in drawing conclusions. These are:

Methyl alcohol may develop its lethal action through three different avenues of entrance into the system; namely, ingestion, inhalation, and cutaneous absorption.

The presence of various impurities does not influence the toxic action, and it is generally believed that the effect is due to a property incident in the methyl alcohol itself.

Methyl alcohol is a poison in which idiosyncrasy plays an important part, some persons being greatly affected by doses that would not harm the majority of people.

There is no evidence to show that a tolerance to methyl alcohol can be developed.

Man appears to be relatively more susceptible to a poison like methyl alcohol than is the dog or the rabbit, for it seems that poisons which powerfully affect the highly differentiated nerve structures are proportionately more dangerous the more highly developed the nervous system.

The fate of methyl alcohol in the human body is not definitely known. There is evidence suggesting that it is not the methyl alcohol itself but some of the chemical by-products of incomplete oxidation that originate these poisonous effects. It appears that formaldehyde and formic acid are the chief toxic agents, although there may be others. The toxic effect is thought to be due to the circulation of these toxic combinations in the blood and their coming in direct contact with the tissues.

It has been demonstrated that the difference in the character of intoxication between ethyl and methyl alcohol is due to the fate of these substances following their administration. Whereas ethyl alcohol is oxidized into easily excreted products, carbon dioxide and water, methyl alcohol is only partially oxidized and the products of this incomplete oxidation are formaldehyde and formic acid. Some explain this difference in the fate of the two alcohols by the difference in their rate of oxidation. Methyl alcohol in slow oxidation makes formic acid, while in rapid oxidation it forms carbon dioxide and water; hence, when it rapidly oxidizes it is comparatively harmless, while in slow oxidation, which usually occurs in some people, it is exceedingly toxic. The variation in effect on individuals therefore may be partly explained by the rate of oxidation which takes place in the person.

If this transformation of methyl alcohol into formaldehyde and formic acid takes place, we have an example of a poisonous compound forming two intermediate compounds which are much more toxic than the original. It has been estimated that formaldehyde is about 30 times and formic acid 6 times more toxic than methyl alcohol.

In considering formaldehyde as the intermediate product of oxidation it must be conceded that from a chemical standpoint such formation is possible; but upon surveying the experimental evidence, very little is found to substantiate the claim.

Most evidence points against its presence in the tissues and the only positive evidence found was given by Pohl,[6] who failed to find support for the view that any "considerable quantities" of formaldehyde are formed, but "it may be that formaldehyde is formed and that it is quickly converted into formic acid."

It must therefore be concluded that if formaldehyde is present it is present but a short time, which may, however, be sufficient to produce a toxic action.

In considering the presence of formic acid in the body there is indisputable evidence that it is present, for it is excreted in the urine, but when it is formed and how much is formed is not known. In many instances it is apparently the final oxidation product, although some individuals may have the power to decompose the methyl alcohol further to carbon dioxide and water. That formic acid is not present in the tissues to any degree is evident if tissue analysis can be depended upon as a criterion. Pohl thought it probable that all the methyl alcohol administered is converted into formic acid, that part of the latter is then oxidized to carbon dioxide. As he did not find it in the tissues to any degree he concluded that very probably either methyl alcohol itself or one of its derivatives is retained in the body and is then slowly converted into formic acid. Bongers[7] on the other hand, asserts that after the administration of methyl alcohol considerable quantities of methyl alcohol are excreted in the urine. It would seem from this that not all the methyl alcohol is converted into formic acid.

Varied tests made upon the distillates from tissues appear to establish the fact that methyl alcohol and not formaldehyde and formic acid is the principal recoverable toxic substance. Very rarely have even traces of formaldehyde and formic acid been detected. It therefore seems evident that methyl alcohol itself is retained in the body for some time and is apparently excreted unaltered or as formic acid which apparently is slowly formed.

It seems that the human body in many instances has great difficulty in oxidizing methyl alcohol. It has been stated that but 3 percent of the body metabolism can be attributed to the methyl alcohol, which seems to be conclusive evidence of the inability of the body to cope with it.

In the opinion of certain investigators, there is a more profound disturbance of the metabolism than is indicated by the simple failure of the body properly to oxidize methyl alcohol. Observations support the view that acidosis plays an etiologic role in the production of the symptoms following methyl-alcohol poisoning. As in a variety of other pathologic states where there is a reduction of the reserve alkali of the blood, the exact significance of this reduction is not clearly understood. There is evidence strongly suggesting that the disturbance of the acid-base balance may, in itself, cause definite anatomic changes. It must be conceded that acidosis might be an important factor in producing the poisonous action of methyl alcohol. Harrop and Benedict[8] were the first to treat a patient on this assumption. In the case reported by these authors there was a definite reduction in the reserve alkali and there was also the characteristic air hunger.

A highly significant feature of this phase of the problem is the slow elimination of the methyl alcohol or its conversion products from the organism, which leads to a subtle danger in the form of accumulated toxic products. Investigators have indicated that the probable explanation of the unduly pronounced poisonous character of methyl alcohol is not only the failure of combustion but also the delay in elimination. According to Henderson and Haggard,[9] more than a week

is required to eliminate the methyl alcohol acquired by a single large absorption. If the exposure is repeated before the elimination is completed, a cumulative effect results; the amount absorbed at each exposure is added to that which remains uneliminated. A toxic concentration is thus gradually built up in the blood as a result of repeated exposure to concentrations that do not cause an appreciable effect on a single exposure. Placet[10] has shown that the complete elimination of wood alcohol requires a period of time five times as long as that of ethyl alcohol.

It therefore appears evident that the toxicity of methyl alcohol may to some degree be attributed to the fact that it remains for a long period of time in the animal organism where it has time to produce varied and grave changes of a chemical and chemicophysical nature.

Most evidence points to the fact that the methyl alcohol is distributed very rapidly to all tissues and fluids of the body. There is practically no lag in the methanol-water concentration of the blood behind that found in any tissue at a particular instant regardless of whether the animal was accumulating methanol, was in a steady state, or was eliminating methanol following exposure. Consequently, all kinds of tissue or body cells are exposed to practically the same methanol-water concentration, there being no selective accumulation, retention, or predilection. The results also show that the amount of methyl alcohol in the body or in a particular tissue can be estimated from a determination of the methyl alcohol in any tissue or fluid.

It seems, therefore, that once consumed or inhaled, methyl alcohol quickly disperses to all tissues of the body, having no selective affinity but apparently injuring by direct action the more highly specialized tissues of the retina, brain, kidneys, and liver and to a lesser extent the other tissues. Experimental data confirm this fact as regards the eye because it has been demonstrated that the substances produced in the body by poisoning with methyl alcohol penetrate the eye readily.

On the other hand, there is some evidence to prove that methyl alcohol has a marked selective affinity for the most highly differentiated nerve elements of man. According to this evidence, the various organs do not show identical findings in the fixation of methyl alcohol; the brain and other nerve tissues exhibit a decided electivity for this substance, and contain the largest quantities of it. Liver, kidney, and muscles then show decreasing proportions of it. The specific affinity is in accord with that which might be expected from its lipoid make-up. This is explained by the fact that the alcohols, like ether, chloroform, and other volatile narcotics, are notably soluble in lipoids such as those characterizing the nervous system. With equal concentration of ethyl and methyl alcohol, methyl alcohol has the greater effect of modifying the lipoid content of organs. It should also be noted in this connection that there is a considerable increase in the fatty-acid and cholesterol content of the blood serum, resulting from acute experimental poisoning with methyl alcohol.

Furthermore, experimental evidence indicates that there is a greater absorption of methyl alcohol in the retina than there is of ethyl alcohol.

It is of importance to trace the ultimate fate of methyl alcohol in the body. Whereas ethyl alcohol is eliminated from the body chiefly through the lungs and, to a far greater extent, through oxidation in the tissues, methyl alcohol is also eliminated through the lungs, but is only to a small extent oxidized in the tissues. It is stated that only about 10 percent of the total amount of ethyl alcohol which dis-

appears from the body is eliminated in the expired air. Of methyl alcohol, on the contrary, more than 70 percent of the amount that disappears from the body appears in the expired air.

Voltz and Dietrich[11] found that after administration of 2 c.c. of methyl alcohol per kilogram of the body weight of a dog, 24.3 percent was excreted in 48 hours, of which 21.5 percent was in the expired air, and 2.18 percent in the urine. As 36.7 percent was found in the body, it follows that only 39.0 percent was oxidized in the body. If the caloric value of the methyl alcohol oxidized is calculated, it will be found that this represents only about 3 percent of the total metabolism of the body. These results are in marked contrast to those obtained in studies of ethyl alcohol under analogous conditions. It seems evident therefore that the bulk of poison is eliminated through the lungs, skin, and kidneys.

Comment. To draw conclusions from the data available is difficult. We must keep in mind that most of the positive evidence is the result of animal experimentation and may not hold true for man. It is to be regretted that so little effort has been made to obtain toxicologic data from the bodies of people who die as the result of methyl-alcohol poisoning. In a few instances the tissues were analyzed for methyl alcohol only, but nothing has been done that can be called conclusive. Considering the number of fatalities, from this form of poisoning the thoroughness of our scientific work leaves much to be desired. It is therefore evident that we are obliged to a great extent to draw conclusions on suppositions based mainly on theory and animal experimentation.

It seems evident that methyl alcohol cannot be oxidized readily by some individuals and consequently acts as a poison. It is most probable that the toxic substances remain in the system as such and are distributed to all of the tissues. Because of their prolonged contact with the tissues they cause pathologic changes, but to a greater degree in the highly specialized tissues such as the central nervous system, kidney, liver, and other organs. It is possible that the more highly developed tissues of the central nervous system are most affected because of their chemical structure and the resulting disturbance in their nutrition.

In review of the evidence at hand it does not seem logical to conclude that one specific substance causes the change. It would appear instead to be due to several factors. A profound change in the chemistry of the body caused by a lack of chemical balance such as is seen in instances of acidosis might be a factor. In addition to this, there could be a direct chemical action of methyl alcohol itself or in combination with the products of oxidation.

The degree of these reactions would naturally vary with the individual tolerance or the ability to cope with the drug.

It is significant that the patient in most of these cases does not experience an immediate toxic effect. It seems logical that if methyl alcohol were the only toxic agent, the patient would evince the profound toxic effect immediately upon taking the alcohol, for it is known that the latter is absorbed and circulates in the blood, almost immediately coming in contact with sensitive tissues. Instead, toxic symptoms in most cases are manifested many hours later. This would point to the fact that the pathologic changes occur after some drastic chemical upheaval has taken place in the chemistry of the body, such as is seen in acidosis or as the result of oxidation.

Just what action is responsible for the pathologic change it is difficult to state. The presence of methyl alcohol has been demonstrated in the tissues, but there is

no definite evidence to prove the presence of formaldehyde or formic acid in the tissues. That formic acid is formed in the body is proved by its excretion from the kidneys. The fact that it is excreted for such a long period suggests that the transformation into formic acid is a very gradual process. The exact period of time during which the formic acid remains in the body is probably of little significance, for a chemical of this degree of toxicity need act but for a moment to produce pathologic changes.

Admitting that methyl alcohol has an effect, the presence of its by-products is strong presumptive evidence that these are additional toxic elements which either alone or in combination with the alcohol cause a profound alteration in the chemistry of the body cells. This change in the body chemistry could produce an acidosis which in combination with the other factors causes pathologic manifestations in all tissues and especially in the tissues of lipoidal structure such as the retina and brain. We know that these highly specialized tissues are always more sensitive and will show degenerative changes even in a temporary upset that interferes with the normal metabolism of its cells.

From the data available, it may be stated that some chemical combinations are not tolerated by the body so readily as are others. Perhaps one of those most poorly tolerated by a large percentage of people is methyl alcohol. Although some individuals have the metabolic ability to cope with this drug, the greater number do not, and when it is taken into the body the abnormal metabolic processes that do occur produce chemical compounds that tend to act as poisons and alter the normal chemical balance so necessary to physical well being. It is generally known, and confirmed by the author's experiments on animals, that one of the oxidation products—namely, formic acid—can cause changes similar to those produced by methyl alcohol alone. It would be incorrect to state that because formic acid is known to be present in the body during the time of the toxic effect, it alone is the causative agent; but rather that formic acid is a factor and very probably acts in conjunction with methyl alcohol and other oxidation products to produce the pathologic changes. There is no conclusive proof that methyl alcohol alone is responsible, and until further proof is available the aforementioned statement may stand as a possible deduction.

Subjective ocular symptoms

Visual acuity

Fairly characteristic changes in the visual acuity are found in cases of methyl-alcohol poisoning.

In acute cases, the changes are sufficiently constant to be diagnostic. The characteristic visual change is first of all a sudden diminution of vision which may be of marked degree. This is followed by a gradual improvement in a few weeks, but is followed later by a gradual loss of vision which may progress to total blindness.

Comment. It is fairly accurate to assume that the initial loss of vision may be caused by the action of the chemical on either the ganglion cells, the nerve fibers, or both. Its sudden onset, followed in a few weeks by a return of vision, suggests that there is at first an edema of the tissues. Not necessarily all the tissue cells are involved. Microscopic study shows that the cells may be destroyed in patches, with some fairly normal cells between the areas of destruction. It is conceivable that the edema which undoubtedly results would for the time being inhibit the action of these undestroyed nerve cells, temporarily causing the total or almost total loss

of vision. The edema may be localized in the nerve, the retina, or both, but, judging from the ophthalmoscopic pictures, it is most frequently seen in the region of the papilla. When the ophthalmoscope does not show changes referable to edema, the latter may be retrobulbar. It is also possible that a retinal and choroidal edema may be present but not evident under the ophthalmoscope.

After a few weeks, the edema subsides and the ganglion cells that were not previously destroyed again function so that a certain degree of vision returns. Because of the disturbed nutrition resulting from the toxic effect on the cell and the edema during the acute process, many of these partially affected cells may die; this would account for the gradual second reduction in vision. The final vision depends upon the number of cells that survive. In the final stage, only a few cells may remain sufficiently normal to function, and the vision may be practically gone. In other cases, in which there is but a slight permanent loss of vision, only a few cells have been destroyed.

In order to appreciate these statements recourse must be had to a study of microscopic slides. In the retina may be seen a total destruction of ganglion cells, and adjacent to these cells ranging from normal to complete destruction. The edema is also definitely present and must inhibit the metabolism of the still undestroyed cells.

In the chronic cases, the gradual loss of vision follows the same process to a less degree. There is no sudden death of the ganglion cells and very little edema, but rather a gradual loss of vitality due to the altered metabolism of these highly sensitized cells.

PERIMETRY DATA

The perimetry findings are not characteristic. Scotoma are the most frequent finding and may be single or multiple. A central scotoma is the most constant finding. There is frequently a peripheral contraction of the field which varies greatly in degree and position.

Comment. From this observation, it is evident that the toxic effect is diffuse and variable. The constant occurrence of scotomata suggests that the effect varies in intensity, some areas being profoundly affected. The frequency of the central scotoma suggests the papillomacular bundle as an important point of involvement.

Because the ophthalmoscopic picture so frequently indicates a retrobulbar involvement or an involvement of the optic disc with little or no visible change in the retina, it would seem logical to conclude that the scotomata are the result of an optic-nerve edema. It is not certain, however, that they are not the result of localized involvement of the retina also. The variability of the perimetry findings over a period of time is in keeping with the visual acuity, and can be attributed to the same process.

It seems evident that with regard to the perimetry findings, a rule as to the exact structure affected cannot be established. Undoubtedly, both the retina and the nerve are involved in all cases; in some, however, one or the other may show the predominating change. From the perimetric evidence alone, one is inclined to consider the optic nerve as the portion chiefly affected, because the perimetric changes are more characteristic of this type of involvement.

OBJECTIVE OCULAR FINDINGS

EXTERNAL

The objective findings give evidence of a disturbance in the pupillary and accommodation reflex arcs. That the involvement is variable is shown by the variable pupillary and accommodative reactions.

The symptom of ocular tenderness, both on pressure and on movement of the globe, is evidence of an ocular or retrobulbar congestion or edema. The picture

can be described as comprising phenomena which accompany an acute edema.

Comment. As to the localizing value, the objective findings suggest an involvement of the entire nerve and vascular elements of the eyeball, together with certain suggestions of retrobulbar involvement. There are also findings which prove that the reflex arcs of the pupil and accommodative mechanism are affected, pointing to a central involvement. The presence of ptosis and the involvement of certain extraocular muscles suggest a diffuse affection of nerves other than the optic and in all probability located in the higher centers.

OPHTHALMOSCOPIC DATA

From a study of the various ophthalmoscopic reports, it is evident that in the acute stage, the optic nerve is the most frequently involved part of the eye.

The process may at first involve the retrobulbar portion of the optic nerve only, or it may spread forward to include the papilla. It may involve the papilla from the onset. Most reports make little or no mention of the retina except the portion surrounding the papilla.

There are indications of circulatory disturbance with edema. The picture varies from a congestion of the nerve head to an intense edema. Mention is made of the dilated retinal vessels.

The optic atrophy that follows is proportional to the primary nerve involvement.

Comment. It seems evident from these data that the optic nerve is the portion of the visual apparatus primarily affected, and the process suggests an edema that may vary in degree. At least this would be one explanation for the ophthalmoscopic description given in the various cases reported. In the greatest number of these it is noted that the optic papilla shows signs of congestion or edema at various stages of severity; retinal edema is present but gradually diminishes in degree away from the disc. The retina not adjacent to the disc may show no signs of pathologic change except for hyperemia.

It is difficult to understand this picture when the microscopic descriptions emphasize so strongly the retinal phase of the change and show so little evidence of optic-nerve disturbance. It is, of course, possible that the retinal edema by comparison appears insignificant and gives the impression of a mere congestion when, in reality, it is quite severe. In other words, the marked optic-nerve involvement as seen with the ophthalmoscope does not preclude edema or destruction of the retinal elements. The absence of definite choroidal changes would tend to minimize the retinal ophthalmoscopic picture.

One may venture the opinion that in cases where the optic-nerve change is the predominating factor, a similar involvement occurs in the retina and choroid that is not shown ophthalmoscopically except for what appears to be hyperemia. The direct action of the toxemia in the retina may cause necrosis, but with little reaction visible ophthalmoscopically.

Undoubtedly, some cases are more definitely retrobulbar than others, whereas others show more intraocular changes. It seems that all of them on examination will exhibit some signs of involvement of both elements.

Another factor which indicates a more general involvement than merely the optic nerve is the postneuritic atrophy that develops. In these cases, reports show the presence of retinal atrophy as well.

It therefore seems plausible to conclude that the ophthalmoscopic evidence bears out the contention that the entire nerve structure of the eye is involved, including the retina and optic nerve. In addition to this there is a choroidal disturbance. The process is not always uniformly the same; instead, one part may

show the predominating picture of pathologic change.

It seems evident that the initial tissue injury is manifested ophthalmoscopically as an edema or hyperemia only, and that undoubtedly many retinal changes, not visible with the ophthalmoscope but none the less important, may not be observable.

Microscopic evidence found in the human eye

The following summary describes the significant changes observed in the cases reported in the literature:

In the autopsies reported by Pick and Bielschowsky,[12] the most interesting histologic findings appeared in the ganglion-cell layer of the retina, in comparison with which the other layers of the retina were only slightly altered. The tangible changes were demonstrable only in the inner granular layer where an agglomeration of the chromatin substance into coarse masses had taken place.

In the retrobulbar section of the optic nerve, changes were found which, however, in comparison with those in the retina, seemed trivial. In occasional medullary sheaths, a fine-grained fatty degeneration was found. There were to be noted, at some points, swellings and inflations in the axis cylinders. If all these findings in the optic nerve are taken together, we may say with certainty that an acute destruction of the nerve substance must have taken place.

In the central nervous system, there were both chronic and recent changes in all three cases. The chronic changes were no doubt due to a chronic alcoholism in each case. The acute changes were exclusively in the ganglion cells. Compared with the changes in the retina, these were only trivial, from a quantitative as well as a qualitative point of view.

Comment. These findings are significant because they describe in considerable detail the results as found in the retina, optic nerve, and the higher centers in three patients who died of acute methyl-alcohol poisoning. It is the most complete description of this situation in the literature and offers most significant data from which conclusions can be drawn. However, the question of post-mortem changes arises, and there is no way of determining its validity. It may be said that the described changes are very suggestive of post-mortem changes. This point is emphasized by study of the author's cases in which post-mortem changes occurred. These showed a striking similarity to those described by Pick and Bielschowsky.

The latter's statement that the most important changes occurred in the ganglion cells bears out the findings in animal experimentation. They also stress the observation that the changes in the optic nerves were slight by comparison. In spite of the fact that they minimize the optic-nerve changes, there is evidence of pathologic processes which should not be minimized. The degenerative changes in the medullary sheaths and the swelling of the nerve fibers are definite signs of optic-nerve injury.

In the central nervous system the finding of ganglion-cell destruction is significant and shows that the process is not confined to the eye.

The case reported by Rymowitsch[13] was that of a man who died of chronic methyl-alcohol poisoning. He noted hydropic and fatty degeneration of the retinal ganglion cells, varicose hypertrophy of the nerve fibers, and edematous saturation of the granular layers. No detailed account was recorded.

Comment. The report is much too brief to be of scientific value. It does, however, indicate changes in the retina that seem to be characteristic.

In Schwartz's[14] two cases in which death occurred from methyl-alcohol poisoning, the following facts were noted: There were no changes in the optic nerves; there were alterations, however,

in the vagus and phrenic nerves. Changes found in the retina accounted for the blindness.

Comment. The report is much too brief to be of scientific value. It is significant that no changes were found in the optic nerves. Unfortunately, the changes in the retina, vagus, and phrenic nerves were not described.

In MacDonald's[15] three patients who died as a result of imbibing methyl alcohol, the following changes were noted.

Case 1. The retina showed marked degeneration in the ganglion-cell layer. The vessels of the choroid were considerably congested.

Case 2. The ganglion cells were decreased in number and degenerated, and cystic spaces were seen throughout this layer. The vessels of the choroid were markedly congested.

Case 3. The retina showed marked changes. The ganglion cells were decreased in number, and cystic spaces were seen throughout this and the nerve-fiber layer.

In view of the well-known early post-mortem degenerative changes that take place in the delicate ganglion-cell structure, MacDowell could not say that his findings were of value; they suggest that the central scotoma and loss of vision were due to toxic degenerative changes that take place in the ganglion cells. He believed that the subsequent changes which result in optic atrophy are due to ascending degeneration of the nerve fiber following the damage to the ganglion cell. The optic-nerve changes, he believed, to be late, for no pathologic alteration could be observed in the optic nerves of any of his cases.

Comment. Without doubt, post-mortem changes account for some of these tissue changes, and it is difficult to evaluate the findings. The cases were so acute that the pathologic changes had not progressed very far. It is important to note the absence of signs of edema in the retina and the absence of signs of pathologic involvement in the optic nerves.

In Menne's[16] two patients who died of methyl-alcohol poisoning, the following points were noted.

Microscopically, there was little change in the optic nerves except edema and hyperemia and some patchy proliferation of glial cells. The most pronounced alterations were observed in the ganglion cells of the retinas, most marked nearest the disc. There were no noteworthy changes in the glial cells except for marked edema.

Comment. It is important to note the presence of edema of the optic nerve and the fact that the ganglion-cell layers again showed the greater change. Edema of the retina was also noted. It is unfortunate that more detail was not given so that a proper evaluation could be made.

The author's two cases were the result of methyl-alcohol poisoning with fatal outcome. The interpretation of the findings is as follows.

CASE 1, A. There appeared to be a small amount of papilledema. Disintegration of the elements was observed in the rods and cones, forming an albuminouslike precipitate. There was a wealth of ganglion cells and this layer showed no evidences of increased gliosis. However, practically all of the ganglion-cell nuclei were pushed to the extreme periphery of the cell. In many of the cells the Nissl substance was arranged in a peripheral ring, while in still other cells there was more advanced dissolution of the Nissl substance indicating chromatolytic changes. All the ganglion cells were distinctly swollen, including those in the macular region. This perhaps represents an early stage in a destructive process.

CASE 1, B. This eye was similar to the preceding one.

CASE 2, A. There was a definite edema of the nerve head, more marked than in the preceding eye. There seemed also to be

an increase in the glial elements in the nerve-fiber layer of the retina surrounding the disc and passing into the optic nerve. The rod-and-cone layer had undergone dissolution. The ganglion cells were quite plentiful, but there was an increased number of glial cells in this layer. The ganglion cells themselves were swollen. The nuclei tended to bulge peripherally from the cell body. The Nissl substance had disintegrated, and in some cells was placed peripherally; in others it had taken on a finely granular appearance; and in still others the cell had only a shadowy appearance. It seemed that many of the ganglion cells in the macular region were better preserved than those in the periphery.

CASE 2, B. This was similar to A. There was an occasional normal ganglion cell, however, and in places the retina was detached because of the great accumulation of debris from the disintegrated rod-and-cone layer.

The optic nerves in 58 A and B appeared to be normal; that of 59 B showed some pink-staining areas which had the characteristics of edema, but no change was apparent in that of 59 A.

Comment. In these cases there should have been obvious post-mortem changes in the retina because the specimens were not fixed in formalin until 12 hours after death. However, the material was refrigerated. Evidently some of the changes are *post mortem.* It is significant that they correspond very closely to the retinal changes reported as occurring in the other cases, and the question naturally arises as to how many of these are due to post-mortem changes.

In the author's cases the engorged choroidal vessels and some edema of the retina are worthy of note. Also of importance is the presence of optic-nerve changes in one case.

To draw conclusions from the preceding autopsy reports is difficult because: (1) there are not sufficient cases; (2) the reports are not complete; (3) there is a possibility that the tissues were not fixed immediately and that many of the findings are the result of post-mortem changes.

The findings that are most significant emphasize the retinal changes, which are chiefly in the ganglion layer. It should be borne in mind that post-mortem processes would cause alterations similar to these. Undoubtedly, some of the changes are the result of the toxic process, but, to be scientifically accurate, it is difficult to ascertain how many are actually due to this cause.

It is rather significant that there were few changes in the optic nerves. Although there were some changes that suggest a toxic process, many were undoubtedly *post mortem.*

If we can assume that the reported findings are not *post mortem,* we have indeed valuable data. We can then say with assurance that the retina suffers most from the toxic exposure and especially the ganglion cells. This would be expected because of their greater sensitivity to change. The presence of injury in the ganglion cells of the brain is proof that similar changes are found elsewhere in the body.

The presence of degenerative changes in the optic nerves in some of the cases shows that the process is not confined to the retina. Likewise, edema was present in both the retina and the optic nerve. The absence of pathologic changes in the optic nerve in many instances may be due to the acute process, the type of tissue arrangement where early changes may not show so readily, and the possibility of improper staining to show these early changes.

The presence of choroidal congestion appears to indicate that the vascular portion of the eye is involved. Some investigators claim that the entire process is a vascular one, but this does not appear to

be the case, judging from the description given. It must be admitted that the evidence of changes in the human eye is the most forcible argument that can be presented as to the pathologic process resulting from methyl-alcohol poisoning.

Animal experimentation carried out by other investigators to determine the effect of methyl alcohol on the ocular structures

The essential facts concerning these experiments are as follows:

In one dog Holden[17] found degenerative changes in the ganglion-cell and the nerve-fiber layers of the retina, and the medullary sheaths of the fibers of the optic nerve. The author concluded that the retina is affected primarily, and the change in the optic nerve represents a secondary stage of the process.

Comment. It is rather impractical to come to any conclusion after an investigation on one dog. Suspicion arises that post-mortem changes may have given rise to errors in evaluating the findings.

Birch-Hirschfeld[2] experimented with rabbits and chickens and made the following observations: The toxic effect first appeared in the ganglion cells of the retina. After this the inner granules degenerated, later the outer granules.

In only one case could distinct signs of degeneration of the nerve fibers be found, and these appeared in the animal which showed the greatest changes in the retinal layers—in a temporal wedge-shaped region of the cross-section beginning immediately behind the bulbus. There was distinct disintegration of fibers, extending posteriorly for about 5 mm., the remainder of the cross-sections showing fairly normal conditions. In the preparations no sign was found of round-cell infiltration even in the degenerated region, nor a noteworthy connective-tissue proliferation.

Birch-Hirschfeld further stated that without doubt the degenerative changes in the optic nerve were of a secondary nature. This is indicated by their absence in the other cases, where the toxic effect on the retinal cells was less pronounced.

Comment. This research is undoubtedly significant; that it has been recognized as such is evident from the repeated references to it in the literature. Critically considered, however, it should be borne in mind that these findings apply to rabbits and chickens and are not necessarily indicative of what may be found in the human eye. There is also the possibility that other factors enter into the situation which may produce some of the changes: (1) post-mortem changes which appear so rapidly in the retina; (2) trauma as the result of killing the animal; (3) imperfect staining and fixing.

If his work is scientifically accurate, his data do bear out his contention that methyl alcohol, even in small doses in the experimental animal (rabbit and chicken), in the first place appreciably injures the cells of the retina; and that only in secondary fashion can the degenerative processes occur in the optic nerve. There must have been some doubt in his mind as to the accuracy of this work because in 1920 he repeated it.

Friedenwald,[5] working on a rabbit, noted the toxic effect on the ganglion cells of the retina. The retinal ganglion cells showed marked degeneration, and the inner and outer nuclear layers were less affected.

Comment. The same criticism may be applied to this work that applied to Holden's. Insufficient data were presented to substantiate the conclusions.

Tyson and Schoenberg,[18] working with guinea pigs, rabbits, dogs, and a monkey, concluded that microscopic findings indicated an edema of the tissues with very early signs of beginning degeneration of the ganglion layer of the retina.

They found that the choroid gave the

impression of hyperemia. As to the retina, the rods and cones and the external nuclear layer were normal. The outer reticular layer was slightly edematous, the inner nuclear layer normal, the inner reticular layer also slightly edematous. The ganglion cells were swollen and surrounded by clear areas, the nuclei being displaced far toward the periphery. The inner layers of the retina showed some edema. The medullary sheath of the optic nerve took Weigert's stain rather weakly.

Comment. This work is especially significant because it confirms the findings of retinal degeneration with ophthalmoscopic evidence to support it.

The change in H-ion concentration of the aqueous and evidence of acidosis are suggestive of chemical changes in the eyeball that substantiate to a measure their theory as to the process leading to the retinal degeneration.

The evidence they obtained of the increased susceptibility of higher animals is valuable; of special significance is their contention that methyl alcohol is a true hematoxin and produces a degenerative change in all tissues.

Kazas,[19] in his work on the effect of methyl alcohol on rabbits, found that the general picture of changes in the retina, except the degenerative process, presented the phenomena of dropsical saturation. The degeneration was not always connected with dropsy. Changes in the retina were markedly expressed in all its layers including the layer of rods and cones. An adipose degeneration of high grade was noted, not only in the layer of nerve fibers but also in the ganglion-cell layer, in the cells proper, and in the inner molecular and nuclear layers.

Adipose degeneration was expressed in all optic nerves. A considerable increase of connective tissue was found. Adipose degeneration was markedly expressed in the N. oculomotorius and the chiasma.

He therefore succeeded in obtaining changes as follows: in the vascular membrane; in the membranes of the optic nerve; in the retina, beginning with dropsy and degeneration up to albuminuric retinitis; and in the optic nerve, beginning with parenchymatous degenerated neuritis up to axial atrophy.

Comment. The results of this investigation appear to confirm the previous research on this subject. The microscopic picture reported is in agreement with that observed by others, although this writer lays special stress on the independence of the degenerative changes and the dropsy changes. The finding of adipose degeneration in the optic nerve and the oculomotor nerve is especially important. The increase of connective tissue is significant. Important also is his contention that the affection of the nerves was independent of the retinal changes. His explanation of the pathologic process is worthy of thought.

Igersheimer and Verzar[20] attempted to determine whether the sense of light might be used as a clinical criterion of the toxic effect upon the retina. As experimental animals they chose chickens.

They concluded that the light perception was temporarily impaired three weeks after the beginning of the poisoning. There was then complete restoration; after four additional weeks of poisoning, the perception of light was again reduced. The retina showed no changes of note.

Comment. The significance of this research is that no pathologic changes were noted in the chickens' eyes. The technique of applying the drug was apparently correct, and the method of sectioning the eyes was apparently not at fault. The writers emphasize the point that acute intoxication was avoided, and it is possible that this avoidance may account for the absence of retinal pathology. The

fact remains that under careful experimental conditions the retina showed no evidence of pathology.

Schanz[21] believed that between the taking of the poison and the onset of blindness there is an interval in which light has a sensitizing effect which must be necessary before the poison can have its effect. As an experimental confirmation of this theory, he gave methyl alcohol to three rabbits, protected one eye from light, and exposed the other to the sun for a number of hours, five or six times in the course of several weeks. He considered the toxic amblyopia to be the result of a sensitization injury to the retina, which absorbed more light, especially short-wave rays, under the influence of sensitizers. In one of these experimental rabbits, killed on the nineteenth day after the last exposure, he found "rather large exudates in the lower half of the retina of the exposed eye, while the protected eye was free from every change."

In the eye exposed to methyl alcohol, he found a distinct diffuse degeneration of the entire cross-section of the optic nerve behind the point where the vessels enter the eyeball. The optic nerves of the eye kept in darkness were found to be normal.

Comment. This experiment proves nothing of note. The insufficient data do not allow conclusions to be drawn. The theory that light is a factor, acting in conjunction with the methyl alcohol to produce retinal changes, is a new approach but does not appear to have much basis for acceptance.

In 1920 Birch-Hirschfeld[3] repeated his experiments, using dogs and monkeys. He found that distinct signs of degeneration (analogous to those previously found in rabbits and chickens following the same form of intoxication) were present in the ganglion cells.

Extensive degenerative changes could be observed even in the beginning portion of the medullary optic nerve, immediately behind the lamina cribrosa. These changes did not appear in the entire cross-section. There were all stages of change ranging from beginning partial degeneration of individual fibers to practically complete disintegration of the entire bundle; but in the degenerated areas it showed distinct changes.

The primary change in the glial tissue rests upon a degenerative process; this degenerative process the author assumed to be due to edematous saturation leading to loosening and disintegration of the fibers.

He concluded that the degeneration of the nerve fibers in the optic nerve was not the result of pressure necrosis due to the proliferated septal tissue or similar tissue showing inflammatory infiltration.

In view of this, and of the normal macroscopic condition of the optic nerve with reference to size of the cross-section and consistency, the author assumed that the exudative processes in the nerve trunk had not yet fully developed.

Comment. This research confirmed Birch-Hirschfeld's earlier findings and in addition demonstrated their presence in higher forms of animals, such as the monkey. His conclusions concerning the optic-nerve findings seem to be more definite in this investigation, especially the changes in the nerve fibers.

He stresses the absence of inflammatory reaction and edema, although the nerve tissue showed extensive degeneration in areas. The degeneration also involved the glial tissue and suggests that it is the result of the direct action of the poison.

De Schweinitz[4] examined dogs which had been acutely and chronically poisoned by methyl alcohol and in no case did microscopic study reveal pathologic changes in the retina.

Comment. These findings are of special significance. Although the research is brief, it is, as is characteristic of this author's work, most reliable. The absence of positive findings is in wide variance with other similar work and leaves it all open to question.

Friedenwald and Felty[22] performed a similar set of experiments using rabbits, guinea pigs, and dogs.

They were unable to produce any retinal or optic-nerve lesions with methyl alcohol and concluded that the original reports of Birch-Hirschfeld in regard to alleged changes in ganglion cells were artifacts, since they could produce similar changes in material from normal animals by variations in fixation and embedding.

Comment. For scientific accuracy of comparison, it is of value to compare the methods used with those used by others who did find retinal changes. Friedenwald is an accurate observer and this adds weight to the importance of his findings.

Schwarzkopf[23] experimented with rabbits and dogs, and studied the effect of light in relation to ocular changes.

In the retina he found pronounced degeneration, chiefly in the ganglion cells. Inflation of the cell body and nucleus, to the point of obliteration of the cell boundaries, alternated with shrinkage processes and clumping of the chromatin. There was no edema. The vessels were normal. The inner granules presented indistinct chromatin structure, inflation, and chromatolysis.

In the optic nerve a bilateral diffuse degeneration was observed immediately behind the bulbus, almost to the point of entrance of the vessels. Enlargement of the septa and multiplication of nuclei occurred only in the anterior sections. There was inflammatory infiltration.

Comment. Schwarzkopf's anatomic investigations are a complete confirmation of the Birch-Hirschfeld results. In the retina, the ganglion-cell layer offered the first and most conspicuous changes. It is especially significant that he found degenerative changes in the optic nerves immediately behind the eyeball.

Scott, Helz and McCord[24] performed experiments on 31 monkeys, 58 rabbits, and 176 white mice.

Upon studying the eyes and optic nerves of these animals these investigators found constant changes both in retina and nerve. However the changes in the retina predominated and were uniformly of the nature of an acute toxic lesion. The vessels of the choroid were markedly congested. The entire retina was edematous, but especially the fiber and ganglionic-cell layers. The ganglion cells were degenerated. This degeneration was patchy in occurrence, normal areas being immediately adjacent to markedly degenerated ones. These degenerated areas were not confined to any one portion of the retina but were scattered throughout. These retinal changes were quite similar to those found by MacDonald in human cases, and by Holden, Friedenwald, Tyson and Schoenberg, and Birch-Hirschfeld in experimental animals. It seemed not uncommon to find degenerations in the retina in the absence of any degenerative changes in the optic nerve.

Comment. As in other works on animals the retinal changes seemed to predominate. The findings in this work were in accord with the changes found by other investigators.

To summarize the results of this experimental work: It is interesting to note that nine papers reported definite pathologic changes in the retina and optic nerve. The authors of three reports failed to find evidence of change.

In all nine instances the findings were in fair agreement. In describing the retina, it was common to find the changes

consisted of definite degenerative alterations in the ganglion cells and a change of less degree in the other layers. A typical statement reads as follows:

"The changes in the retina predominated and were uniformly of the nature of an acute toxic lesion. The vessels of the choroid were markedly congested. The entire retina was edematous, but especially the fiber and ganglionic cell layers. The retinal ganglion cells showed marked degeneration; the inner and outer nuclear layers were less affected. This degeneration was patchy in occurrence, normal areas being immediately adjacent to markedly degenerated ones. These degenerated areas were not confined to any one area of the retina but were scattered throughout."

As regards the optic-nerve changes, all nine authors found evidence of pathologic involvement, and it seemed common to find degenerations in the retina associated with the degenerative changes in the optic nerve. The retinal changes seem to predominate.

It is especially significant that degenerative changes in the optic nerves were found immediately behind the eyeball. Most of the writers agreed that the degenerative changes in the optic nerve were less conspicuous. The following quotations are characteristic:

"In cross-sections, extensive degenerative changes could be observed even in the beginning portion of the medullary optic nerve, immediately behind the lamina cribosa. These changes did not appear in the entire cross-section. There were all stages of change ranging from beginning partial degeneration of individual fibers to practically complete disintegration of the entire bundle; but in the degenerated areas there were distinct changes.

"In the preparations was found no sign of round-cell infiltration even in the degenerated region, nor a noteworthy connective-tissue proliferation.

"The primary change of the glial tissue rests upon a degenerative process; this degenerative process was assumed to be due to edematous saturation which leads to loosening and disintegration of the fibers. The degeneration of the nerve fibers in the optic nerve was not the result of pressure necrosis due to the proliferated septum tissue or similar tissue showing inflammatory infiltration."

It seems that the predominant finding in both the retina and the optic nerve was edema. This was associated with signs of necrosis or degeneration of all parts but especially the higher differentiated cells of the retina. There was no evidence of inflammatory infiltration nor of vascular engorgement except for a slight amount in the choriod.

Contrary to these findings are the negative results found in the work of de Schweinitz and Friedenwald. It is difficult to explain the difference in result. As the details of their experimental work were not published, it is impossible to make a fair analysis. It might be of value to mention that de Schweinitz must have been still in doubt, in spite of his experimental work, because he personally suggested to the author that this problem should be solved. The findings of two such reliable observers should be considered significant. The following statement by Friedenwald should be borne in mind in making a final decision:

"The original findings of Birch-Hirschfeld in regard to alleged changes in the Nissl bodies of the ganglion cells were artifacts, since he could produce similar changes in material from normal animals by variations in fixation and embedding."

(To be concluded)

THE USE OF FURMETHIDE IN COMPARISON WITH OTHER MIOTICS FOR THE TREATMENT OF GLAUCOMA*

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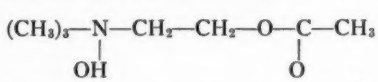
This study was undertaken to compare the clinical value of furmethide with that of mecholyl and prostigmine in the treatment of acute glaucoma, and to study the effect of furmethide in patients with chronic glaucoma in whom the tension had been previously uncontrolled by pilocarpine.

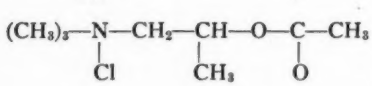
COMPARATIVE PHARMACOLOGY OF MIOTIC DRUGS

Since the discovery of the transmission of nervous impulses in the parasympathetic system by the liberation of acetylcholine, various choline derivatives have been studied for their parasympathomimetic action relative to their possible clinical use. The action of acetylcholine itself is too transient to be of value in clinical use, as acetylcholine is rapidly hydrolyzed by cholinesterase, an enzyme present in all tissues. Mecholyl is also destroyed by cholinesterase, but less readily than is acetylcholine. Furmethide has no ester linkage that can be attacked by cholinesterase and is therefore effective without the synergistic use of a cholinesterase inhibitor such as prostigmine or eserine.

The chemical relationship of furmethide to acetylcholine and mecholyl is shown by the structural formulae:

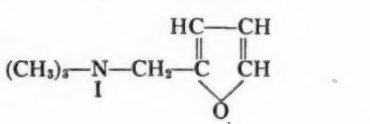


acetylcholine



acetyl-beta-methyl choline chloride

MECHOLYL



furfuryl-trimethyl ammonium iodide

FURMETHIDE

The physiologic action of the cholinergic drugs on the intraocular muscles has been reviewed by Guyton.[1] The parasympathomimetic agents are miotics and vasodilators, and the reduction of tension produced by these drugs in glaucoma is thought to depend upon these properties relative to the formation and absorption of the aqueous.

The ocular pharmacology of furmethide was studied by Myerson and Thau.[2] Solutions of 5 to 20 percent when instilled into the normal human eye were found to produce effects similar to those of mecholyl. These effects appeared more promptly, were of greater intensity, and of longer duration. The pupil began to contract after 2 to 4 minutes, reaching maximal miosis within 5 to 7 minutes. A reduction of intraocular pressure of 3 to 7 mm. was noted after the lapse of 8 to 10 minutes, persisting for 12 to 24 hours. Although a 10-percent solution was easily tolerated, a 20-percent solution induced transient headache and nausea.

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* From the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital and University.

The treatment of primary acute glaucoma

Until the introduction of the synthetic choline derivatives, pilocarpine and eserine were the drugs most frequently used in the treatment of primary acute glaucoma. Since 1939 mecholyl has been used in combination with prostigmine,[3] and in 1941 the use of furmethide was begun.

The cases in this analysis are of patients with primary glaucoma whose intraocular pressure before therapy was begun exceeded 40 mm. Hg (measured by the Schiötz tonometer). Included in the groups are cases of both congestive and of noncongestive glaucoma. Only patients admitted to the wards of the hospital are included in this study.

*The use of furmethide in the treatment of primary acute glaucoma.** The use of furmethide was studied in 23 patients with primary acute glaucoma. One drop of a 10-percent solution of furmethide was instilled into the conjunctival sac every 15 minutes for two hours, then every three hours until the tension was reduced to normal or until operation was performed. No systemic reactions were noted. Locally a transient hyperemia of the conjunctival vessels occurred. Occasionally there was a shallowing of the anterior chamber. It has been our policy in these patients to operate in the interim of lowered tension. The chief purpose of the drug, therefore, is to reduce the tension to a safe preoperative level rather than to avoid operation.

The patients have been divided into three groups: (1) those in whom the tension was reduced to 25 mm. Hg (measured by the Schiötz tonometer); (2) those in whom the tension was reduced to between 26 and 35 mm. Hg (Schiötz), considered to be a relatively safe preoperative level; and (3) those in whom the tension remained above 36 mm. Hg (Schiötz). The results are summarized in table 1. Regarding the primary acute group as a whole, furmethide reduced the tension to 35 mm. or less in 69 percent of the patients.

The cases were further analyzed to determine the influence of the pretreatment tension, the previous use of miotics, and the degree of visual-field loss on the therapeutic efficiency of furmethide.

TABLE 1

Results of furmethide therapy of primary acute glaucoma

Type of Glaucoma	Number of Cases	Tension Post Drug		
		25 mm. or less percent	26-35 mm. percent	36 mm.+ percent
Congestive	16	56	13	31
Noncongestive	7	43	28	28
Total	23	52	17	31

Tension before therapy was begun was between 40 and 55 mm. (S) in 35 percent of the patients, between 56 and 75 mm. (S) in 35 percent, and over 75 mm. (S) in 30 percent. The tension was reduced to 35 mm. or less in 60 percent of the patients whose initial tension was over 55 mm. and in 87 percent of those whose initial tension was below 55 mm.

Sixty-one percent of the patients had been on miotics (usually a 2-percent solution of pilocarpine administered three times daily, with or without eserine ointment at night) before the onset of the immediate elevation of the tension. The tension was reduced to 35 mm. or less in 64 percent of these patients as compared with a similar reduction of tension in 89 percent of the patients who had

* Smith, Kline, and French Laboratories supplied the furmethide used in this study.

received no miotic therapy before furmethide was begun.

The patients were also divided into two groups, those with so-called early or late glaucoma. Early cases of glaucoma were arbitrarily considered to be those in which the field defect was less than 30 degrees in any meridian and the blind spot not enlarged more than 10 degrees in any diameter. All other cases were classified as late. According to this classification, 52 percent of the cases were early, 48 percent of the cases late. The tension was reduced to 35 mm. or less in 67 percent of the early cases and in 74 percent of the late cases.

TABLE 2

RESULTS OF MECHOLYL AND PROSTIGMINE THERAPY OF PRIMARY ACUTE GLAUCOMA[1]

Type of Glaucoma	Number of Cases	Tension Post Drug		
		25 mm. or less percent	26–35 mm. percent	36 mm.+ percent
Congestive	40	40	20	40
Noncongestive	3	0	33	67
Total	43	37	21	42

The use of mecholyl and prostigmine in the treatment of primary acute glaucoma. A study was made of 43 patients with primary acute glaucoma, who were treated with mecholyl and prostigmine. In nearly all of the patients, one drop of 20-percent mecholyl and 5-percent prostigmine solutions were instilled simultaneously every 15 minutes for two hours, and then every three hours until the tension was reduced to normal or until operation was performed. A systemic reaction, characterized by syncope, bradycardia, and fall in blood pressure, occurred in only one patient. The use of atropine intravenously produced prompt recovery. A transient hyperemia of the conjunctival vessels was noted in many of the patients. The results of therapy are summarized in table 2. In the primary acute group as a whole, mecholyl and prostigmine reduced the tension to 35 mm. or less in 58 percent of the patients.

Tension before therapy was begun was between 40 and 55 mm. Hg (S) in 19 percent of the patients, between 56 and 75 mm. (S) in 32 percent, and over 75 mm. (S) in 49 percent. The tension was reduced to 35 mm. or less in 54 percent of the patients whose initial tension was over 55 mm., and in 75 percent of those whose initial tension was below 55 mm.

Fifty-eight percent of the patients had been on miotics before the onset of the present elevation of tension. The tension was reduced to 35 mm. or less in 44 percent of these patients as compared with a similar reduction of tension in 77 percent of the patients who had had no miotic therapy before mecholyl and prostigmine were used.

The same criteria were used in dividing the patients treated with mecholyl and prostigmine into an early and a late group as in those treated with furmethide. Thirty-two percent of the patients treated with mecholyl and prostigmine were classified as early, 68 percent as late. The tension was reduced to 35 mm. or less in 92 percent of the early cases, and in 41 percent of the late cases.

Comparison of furmethide with mecholyl and prostigmine in the treatment of primary acute glaucoma. A comparison of the effectiveness of the two forms of therapy in various stages of primary acute glaucoma is given in table 3. No outstanding difference was found except in the treatment of "early" and of "late" cases. In the "late" cases the difference of 74 percent reduction of tension to 35 mm. or less by furmethide as compared

to 41 percent reduction by mecholyl and prostigmine proved to be of statistical significance ($d/\sqrt{d} = 2.0$), and suggests that furmethide is preferable in late stages of acute glaucoma. Conversely, in "early" cases the 92-percent reduction with mecholyl and prostigmine as compared to 67 percent reduction with furmethide suggests that mecholyl with prostigmine is preferable in early acute glaucoma, although the number of cases treated was too small for this difference in percentages to be quite significant statistically ($d/\sqrt{d} = 1.6$).

TABLE 3

COMPARISON OF THE FAVORABLE EFFECT OF TREATMENT WITH FURMETHIDE AND WITH MECHOLYL AND PROSTIGMINE OF VARIOUS STAGES OF PRIMARY ACUTE GLAUCOMA: PERCENTAGE REDUCTION OF TENSION TO 35 MM. OR LESS

Treatment	Initial Tension over 55 mm. (S) percent	Initial Tension under 55 mm. (S) percent	"Late" Cases* percent	"Early" Cases† percent	Previous Use of Other Miotics percent	No Previous Use of Other Miotics percent	Total percent
Furmethide	60	87	74	67	64	89	69
Mecholyl and Prostigmine	54	75	41	92	44	77	58

* Statistically significant difference in percentages $d/\sqrt{d}=2.0$.
† Not quite statistically significant difference $d/\sqrt{d}=1.6$.

It is of interest to note that the effectiveness of mecholyl and prostigmine varied greatly according to the stage of the glaucoma, whereas the efficacy of furmethide showed no appreciable variation.

THE TREATMENT OF ACUTE SECONDARY GLAUCOMA

The use of furmethide and of mecholyl and prostigmine was studied in a group of patients with acute secondary glaucoma (secondary to cataract extraction, uveitis, trauma, venous thrombosis) whose intraocular pressure before therapy was begun was higher than 40 mm. Hg (S). The method of treatment was the same as in the treatment of patients with primary acute glaucoma. The tension was reduced to 35 mm. or less in 50 percent of the 18 patients treated with furmethide, and in 52 percent of the 19 patients treated with mecholyl and prostigmine. Neither drug had any effect on glaucoma secondary to venous thrombosis.

THE TREATMENT OF PRIMARY CHRONIC GLAUCOMA

The use of furmethide was studied in a group of 20 patients with chronic glaucoma whose tension was uncontrolled by pilocarpine. This group included patients with chronic noncongestive glaucoma and patients with chronic congestive glaucoma. The tension of these patients before furmethide therapy was begun varied from 30 to 40 mm. Hg (S). Most of these patients had been using a 2-percent solution of pilocarpine from three to six times a day previous to the late rise in tension. The therapy for four of the patients was changed to 5-percent furmethide, for the others to 10-percent furmethide from three to six times a day.

On furmethide 15 patients showed an initial drop of 5 mm. or more in tension. In 10 patients the tension was initially reduced to normal, but 5 of these pa-

tients had a subsequent rise of tension after a period of 2 to 9 months, with normal tension and no further loss of field. Four of these latter patients refused operation and were then given a 0.25-percent solution of eserine five times a day, but without effect on the tension.

Summary

Seventy-five percent of the patients showed an initial drop of 5 mm. or more in tension when furmethide was substituted for pilocarpine therapy. In 50 percent of the patients the tension was initially reduced to normal, but in only 25 percent of the patients was the tension maintained at a normal level for an observation period of at least four months.

No systemic nor local reactions to furmethide were noted over these prolonged periods of administration. Occasionally the patients complained of morning headaches or of transient blurring of vision immediately after the installation of the drug. None of the patients developed a local sensitivity to the drug.

Conclusions

1. Furmethide is a parasympathomimetic drug which reduces intraocular pressure in glaucoma.

2. A 10-percent solution of furmethide is on the average as effective in reducing intraocular pressure in cases of primary acute glaucoma as is the synergistic use of a 20-percent solution of mecholyl and a 5-percent solution of prostigmine. In "early" cases therapy with mecholyl and prostigmine is probably preferable, while in "late" cases furmethide seems definitely preferable.

3. A 10-percent solution of furmethide is slightly more effective than a 2-percent solution of pilocarpine in reducing the intraocular pressure in cases of chronic glaucoma. It is nonirritating on prolonged use. It cannot, however, be relied upon to maintain normal intraocular pressure indefinitely. It postpones rather than prevents operation.

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ABSCESS OF THE CRYSTALLINE LENS

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Perforating injuries of the globe frequently involve the lens by causing perforation of the anterior capsule and the production of varying stages of traumatic cataract. If infection accompanies the perforation, a purulent infiltration results in abscess of the lens. Such diagnoses are usually made by pathologic section following enucleation of the infected or shrunken eye. It seems of interest, therefore, to report a case of intraocular infection in which abscess of the crystalline lens dominated the ocular findings, and in which healing occurred with seclusion of the pupil.

In Posey and Wright's textbook, "Diseases of the eye, ear, nose, and throat" (1903), there is a single reference to purulent infiltration of the lens following an iridocyclitis produced by a perforating injury of the ciliary body. An illustration of the pathologic section of the eye accompanies the reference.

Abscess of the lens is not considered under the heading of "Diseases of the lens" in the modern textbooks of Fuchs, Berens, or Duke-Elder, nor is it mentioned in Würdemann's textbook on "Injuries of the eye."

In a recent article on "Lesions in the lens from corneal ulcers" Samuels found only one case, in a large series of eyes enucleated for corneal ulcer with hypopyon, in which there were pus cells within the lens capsule. In this case he could not be sure that the thin posterior capsule was intact, and asserted his continued belief in the active impermeability of the lens capsule to cells.

Jonas Friedenwald stated that "the relation of the lens to intraocular infections is entirely a passive one. It is an excellent culture-medium, and bacteria introduced into its interior grow most luxuriantly. Injuries which involve perforation or rupture of the lens capsule are, therefore, most likely to result in severe infections, for the organisms once in the lens are able to multiply at a rapid rate before they can be reached by pus cells."

Sullivan has commented on the work of Morax and Chiazzaro, who, in enucleating seven eyes following perforating injuries of the lens, with ensuing panophthalmitis, conducted bacteriologic studies in which material obtained directly from the lenses was cultured. In six out of seven cases the microörganism which was the infectious agent in the lens belonged to a group of spore-forming bacilli which have their habitat in the ground and are generally considered as only slightly pathogenic or nonpathogenic. In three cases the infecting organisms were bacilli having the characteristics of Bacillus subtilis. Two cases demonstrated filamentous, gram-positive bacilli showing terminal spores. One case showed a gram-negative bacillus which presented endospores. In one case these observers found a gram-positive, filamentous bacillus which was not spore bearing.

These studies led Morax and Chiazzaro to consider the possibility that the lens tissue might represent a particularly favorable field for the growth of spore-bearing organisms. Accordingly they applied this hypothesis to experimental studies on the eyes of rabbits by injecting cultures of various spore-bearing microörganisms directly into the lens. Spores injected into the anterior chamber disappeared quickly and caused only slight changes. Spores

injected into the lens multiplied rapidly and in considerable numbers, and gave rise to severe inflammatory reactions. In the lens, the microörganisms are protected by the barriers of lens capsule and cortex, and the leukocytes of the aqueous cannot reach them. Pneumococci and staphylococci grew well in the lens substance and produced infections of the lens with subsequent panophthalmitis.

Under these conditions microörganisms which ordinarily are of low vitality or are nonpathogenic in character may change character and destroy a globe, since the lens cortex acts as an excellent culture medium. This may well explain some of the late postoperative cataract infections in which lens material left in the pupillary space incarcerates microorganisms from which, after a prolonged incubation period, infections develop.

Although lens injuries are common in perforating and nonperforating wounds of the globe, infection of the lens was found in but 8 of our series of 73 eyes removed for various reasons following perforating injuries. These eyes were all fixed, sectioned, and examined at the Army Medical Museum, and demonstrated varying degrees of involvement of the lens and globe. The extent of purulent infiltration depends on such factors as the extent of the lens trauma, the virulence of the infecting organisms, the length of time that elapses between the injury and enucleation and the posttraumatic treatment.

In current literature references to abscess of the crystalline lens are very rare. Yver and Barrat reported a case of intraocular infection in which abscess of the lens followed a perforating injury sustained while the patient was chopping wood. On the sixteenth day there was violent pain in the eye and orbit; corneal clouding and hypopyon were present, and a tiny yellow spot was observed on the anterior lens surface. Paracentesis was performed, and culture of the material yielded a growth of staphylococci. The globe was enucleated after 24 hours, and the microscopic section showed the lens capsule to be filled with purulent material.

Busacca has reported what is apparently the first recorded case of abscess of the crystalline lens in which the globe was saved. A young girl was struck in the eye by a penpoint which penetrated the cornea and lens; this was followed by purulent infiltration of the lens. The lens material contained pneumococci, but the eye recovered with seclusion of the pupil. In eight rabbits Busacca punctured the lens through the cornea, using different microörganisms to produce infections. His conclusions were: Infection of the lens is possible only if the anterior or posterior capsule is perforated. Rapid closure of a small puncture wound in the capsule may occur and thus prevent the entrance of germs from the aqueous or may retard their rapid multiplication if they have already gained entrance. Simultaneous injury of the iris causes the infection to run a severe course complicated by iridocyclitis. He found his most severe infections produced by pneumococci, the least severe by gonococci.

Hertel, in an article on "The operative closure of the wound in perforating injuries of the cornea," demonstrated by photomicrograph the pathologic section of an eye containing an abscess of the crystalline lens which followed a perforating injury. As this case illustrates by microscopic section the condition existing in our patient on the occasion of his first visit to our office, we have included it here (fig. 1).

Before the era of chemotherapy practically all eyes suffering from perforating injuries accompanied by infection were lost. It seems worth while, therefore, to record the second case in which the globe

was apparently saved after primary abscess formation in the lens followed penetration of the cornea and lens by a metallic foreign body which was successfully extracted by magnet.

Case report

Mr. J. E. DeL., aged 27 years, while hammering on a steel file, on April 2, 1941, felt something strike the left eye. Five days later he reported for examination to Dr. R. J. Calcote, Little Rock, Arkansas, who provided the following notes: "At that time the pupil dilated evenly and widely and a small scar could be seen near the center of the cornea, with a scar on the lens capsule immediately behind it; also a small piece of steel could easily be seen near the center of the lens, and this was extracted through a keratome incision by the hand magnet. I saw him two weeks later, at which time he had not used atropine for three days and had a very definite iritis. Atropine was again prescribed, and I saw him again three weeks later, with the iritis very definitely improved, but still with considerable inflammatory reaction."

On May 12th the patient reported to our office. There was moderate ciliary injection, although the pupil was widely dilated. A perforating scar in the central cornea, 1 mm. wide in its vertical diameter, was visible. The aqueous was turbid. There was a yellowish area in the anterior lens substance that resembled a purulent focus rather than an opaque change in the character of the lens cortex. The lens was clear peripherally, and the fundus seemed to be normal. The tension to fingers was normal (fig. 2).

The patient was immediately admitted to the Memphis Eye, Ear, Nose, and Throat Hospital, given 20 million typhoid-H antigen intravenously, with atropine and heat locally, and 1½ grains of calomel, followed by a saline purge, internally. The following morning the temperature was 99.5°F. and sulfathiazole was administered, 4 grams being given as the initial dose and 1 gram every six hours thereafter.

Increasing doses of foreign protein in the form of typhoid-H antigen in the amount of 50 million, 75 million, and 100 million were given on May 15th, 18th, and 21st, respectively. Febrile reactions to temperatures of 100°, 101°, and 100°F. were noted. There was a distinct increase in the lens infiltration, with a clumping of cells in the anterior chamber. It was difficult to keep the pupil dilated, and 2-percent ointments of atropine and epinephrine bitartrate were employed.

Fig. 1 (Rychener and Ellett). Microscopic section of penetrating wound of the cornea with abscess in the crystalline lens (E. Hertel).

On May 19th sulfathiazole concentration of the blood was 8.1 mg. percent. The hemoglobin, blood-cell counts, and blood-smear examinations were normal.

On May 23d, the eye showed improvement, and the patient desired to return to his home, about 200 miles away. His chemotherapy was changed to sulfanilamide, and on May 25th the blood concentration for this drug was 4.3 mg. percent. On May 26th he was allowed to go home, and sulfanilamide, 10 grains four times a day, with atropine ointment, 2 percent, and epinephrine bitartrate jelly, 1 percent, to be used alternately in the eye (fig. 3), were prescribed.

Fig. 2 (Rychener and Ellett). Primary abscess of the crystalline lens five weeks after penetrating injury.

Fig. 3 (Rychener and Ellett). Increased infiltration of the lens 11 days later.

Fig. 4 (Rychener and Ellett). Abscess of the lens with hypopyon two months after original injury.

Fig. 5 (Rychener and Ellett). Abscess of the lens with hypopyon during the period of daily paracenteses.

On June 5th he returned, stating that the eye had been comfortable during the interim, but that the vision was reduced to moving objects. There was definite increase in the lens opacity, with hypopyon (fig. 4).

The patient was readmitted to the Hospital and more foreign protein was given, with temperature reaction to 100.5°F. As the hypopyon increased, paracentesis by subconjunctival keratome incision at the 9-o'clock position was done on June 7th. Material was obtained from the aqueous and cultured on brain broth as a preliminary medium, and subcultured on a modified Löffler's medium—agar with dextrose added. On June 9th there was a pure growth of Staphylococcus aureus. The paracentesis wound was reopened daily thereafter, and sulfathiazole in adequate dosage was again administered. Daily paracenteses were performed throughout the period from June 7th to 15th, when the eye began to show evidence of clearing. On June 11th material from the aqueous was again cultured, but there was no growth on the media (fig. 5).

On June 20th the sulfathiazole concentration of the blood was 5.1 mg. percent. On June 21st there was ciliary injection. The cornea showed a number of deep

vessels around the limbus. The anterior chamber was of unusual depth, and one half of it contained a yellowish mass which overlay the pupil. There was light perception with good projection. Tension to fingers was minus. The patient was sent home, and sulfathiazole, 0.5 gm. three times a day, and atropine ointment, 1 percent locally, were ordered.

On July 8th the pupil was filled with a vascularized yellow mass, and there was vascularized matter laterally in the anterior chamber.

On July 23d, when the patient returned, there was definite clearing of the globe, although the pupil was constricted and posterior synechia was evident. The cornea showed some opacities, with superficial and deep vessels. There appeared to be organized material in the anterior chamber, which seemed to be continuous with the lens opacity. From this mass vessels passed on to the iris. Tension to fingers was questionable. Treatment was discontinued.

By November 10th the eye had become

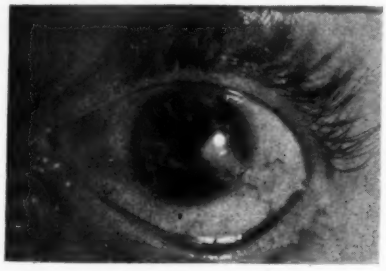

Fig. 6 (Rychener and Ellett). End stage of abscess of the lens. Corneal opacity following trauma to the endothelium, clearing of the anterior chamber, seclusion of the pupil, and secondary glaucoma.

quite white. However, the patient complained of almost daily headache, coming on late in the afternoon; the tension (Schiötz) in this eye was 40 mm. Hg (fig. 6). Pilocarpine solution, 1 percent, three times a day, was prescribed.

On January 13, 1942, tension was 48 mm. Hg, and operation was advised. On February 13th, a corneoscleral trephining was done on the left eye, but a modified form of anterior sclerectomy was employed because the chamber angle above was obstructed by scar tissue and the iris

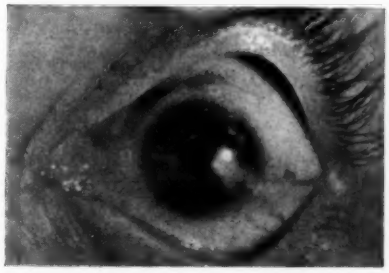

Fig. 7 (Rychener and Ellett). Iridectomy for secondary glaucoma following abscess of the lens.

failed to prolapse. Convalescence was uneventful, and on March 7th the tension was 26 mm. (Schiötz). There was a broad iridectomy, which disclosed deposits of cholesterol under the lens capsule. Medication was discontinued, but finger massage twice daily was instituted. Light projection was normal (fig. 7).

Subsequent observation disclosed a quiet, clear globe and a tendency toward return of hypertension, which was controlled by miotics. The final outcome is doubtful, but at present there is no discomfort.

Summary

1. A case of abscess of the lens treated by chemotherapy and paracentesis, followed by alleviation of the infection and retention of the globe to date, is reported.

2. Early culture of the aqueous or lens substance by hypodermic needle paracentesis, in infections of the anterior segment, may aid in determining the type of medication to employ.

3. Chemotherapy in conjunction with fever therapy is suggested as the first step

in the medicinal treatment of all perforating injuries.

4. Repeated paracenteses are of value in abscess of the anterior segment of the globe; they probably induce a higher concentration of the chemotherapeutic agent in the aqueous, in addition to an increased titer of specific antibodies.

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NEVUS FLAMMEUS ASSOCIATED WITH GLAUCOMA*

Report of a case in which cyclodiathermy was used in an attempt to control the intraocular pressure

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Ophthalmologists have associated glaucoma with telangiectasis of the face since Schirmer[1] first recorded his case in 1860. According to Duke-Elder[2] some 80 cases have subsequently appeared in the literature. The majority of these have been well summarized by Krause,[3] Ballantyne,[4] O'Brien and Potter,[5] and Evans and Evans.[6] It would be needless repetition to report their findings here. Rather it is our wish to report a case in which cyclodiathermy was used to combat the increased intraocular pressure. As far as we have been able to determine, there is no previous report, in the American or British ophthalmic literature, of this procedure being performed for glaucoma associated with nevus flammeus.

* From the Oscar Johnson Institute, Department of Ophthalmology, Washington University School of Medicine. Read before the Saint Louis Ophthalmic Society, October, 1942.

Report of a case

M. B., a white boy, aged 14 years, came to the office of one of us (B. Y. A.) on December 28, 1938, complaining of diminished vision in his right eye. His mother stated that she believed the patient's right eye was larger than his left. These symptoms had been first noticed one year previously. He had never had ocular pain nor frontal headaches. A mild epiphora had been present. Photophobia, purulent exudate, or redness had never been noticed, nor had he ever seen halos.

The past history was noncontributory. His past health had been excellent except for the usual childhood diseases. He had not previously consulted an ophthalmologist. There had been no eye injuries nor inflammations. He had never worn glasses. The family history was entirely negative.

The blood chemistry and urine were

normal. The blood Wassermann test was negative. The patient was well developed. On the right side of his face there was a nevus flammeus that conformed in outline with the skin distribution of the ophthalmic and maxillary branches of the right trigeminal nerve. Otolaryngoscopic consultation revealed the nevus to be present in the mucous membrane of the nose and throat following the same nerve distribution. General physical examination was negative.

In the left eye the vision was 6/6. The conjunctiva was normal. The cornea measured 12 mm. horizontally. The pupil was round, equal in size to that of the right eye, and reacted to direct light, consensually, and in accommodation. Tension was 16 mm. Hg (Schiötz); the exophthalmometer reading, 18 mm. Ophthalmoscopic and slitlamp examinations revealed no abnormalities.

In the right eye the vision was 6/12; with +0.50D. sph. vision was 6/10. The palpebral conjunctiva of both lids was of a diffuse, dark red color. Several vessels in the bulbar conjunctiva were dilated. The cornea was clear and measured 14 mm. horizontally. The anterior chamber was of normal depth. The pupil was round and reacted to direct light, consensually, and in accommodation. There was no heterochromia iridis. Tension was 43 mm. Hg (Schiötz); the exophthalmometer reading, 20 mm. Ophthalmoscopic examination revealed a small posterior capsular lens opacity. The vitreous was clear. There was a deep cup present which included two thirds of the face of the disc and which was depressed about 4 or 5 diopters; the vessels were pushed to the nasal side. The retinal arterioles were in 2:3 ratio, the veins presenting a moderate increase in tortuosity. There was a marked increase is the number of arterial and venous branches. The choroidal vessels appeared to be normal. The macular area was not remarkable, nor were there any hemorrhages, exudates, nor retinal edema.

Slitlamp examination revealed an increase in the number of episcleral vessels. These were dilated. There was no dilatation of the vessels of the iris; the stroma of the iris was within normal limits.

Gonioscopic examination was normal. There were no anterior synechias or other obstruction in the chamber angle.

Perimetric examination showed an enlarged blind spot to be present. The peripheral field was slightly contracted all around, but more markedly in the upper nasal quadrant.

A diagnosis of unilateral hydrophthalmos with homolateral nevus flammeus of the face was established. Pilocarpine hydrochloride 1 percent was prescribed, to be used four times daily.

The pupil constricted promptly and the tension dropped to 30 mm. Hg (Schiötz). The vision improved to 6/5. The patient continued using the pilocarpine for one month, the tension varying between 30 and 38 mm. Suprarenin ointment 2 percent was then used as an adjunct. This caused a slight temporary decrease in the tension. The visual fields showed an increase in the peripheral constriction as well as a developing Bjerrum scotoma. The patient's vision diminished to 6/7.5. He then entered Barnes Hospital, and on June 9, 1939, a corneoscleral trephining was performed, above. Following this the tension stayed within normal limits for 10 months without medication. On April 30, 1940, the tension was found to be 29 mm. Hg (Schiötz). Pilocarpine was again prescribed, but without effect. Suprarenin ointment was then used, and this, with miotics, controlled the tension for six months, when the tension began to rise again. The field changes

were progressing, and fibrous tissue was closing off the trephine opening. The visual acuity was still 6/7.5. On December 27, 1941, the tension was 34 mm., and prostigmin 5 percent was ordered. This proved to be of only temporary benefit. Consultation with Dr. Lawrence Post, as to the advisability of trying Vogt's cyclodiathermy operation, was obtained. Dr. Post agreed that this operation seemed most likely to give permanent relief.

aforementioned sheath of vessels in the area treated. No intraocular hemorrhage occurred, and the postoperative course was uneventful. The tension remained between 13 and 15 mm. Hg for one month, then rose to 27 mm. The vision, on August 1, 1942, was 6/8. Prostigmin was again prescribed, but without effect. The patient again entered Barnes Hospital on August 4th, and a cyclodiathermy operation was performed on the lower half of

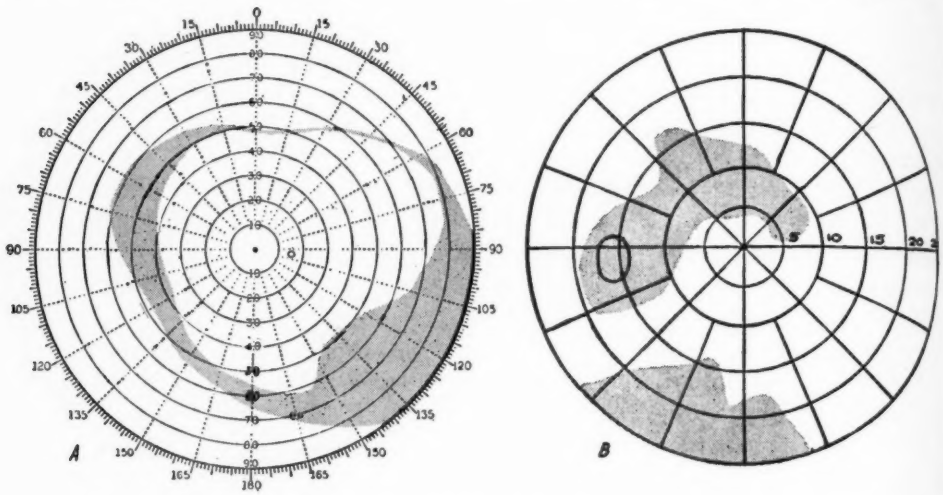

Fig. 1. (Alvis and Toland). Visual fields of the right eye. A, on August 1, 1942, 1 mm. light; B, December 23, 1942, target 3/1,000.

On May 14, 1942, the patient entered Barnes Hospital and a perforating cyclodiathermy, after the method of Vogt,[7] was performed, covering the upper half of the ciliary region. On the operating table a very interesting abnormality was found. There was a sheath of telangiectatic blood vessels lying on the sclera and below Tenon's capsule. This sheath of vessels completely encircled the globe, beginning about 2 mm. behind the limbus and extending as far posteriorly as could be observed through the incision. A 0.5-mm. needle was used to make a double row of punctures extending from the 3:00- to the 9:00-o'clock position. The diathermy completely coagulated the ciliary region. The same vascular abnormality was found below, but it was not so marked as it was above. During the postoperative course, the anterior portion of the sclera remained congested and edematous. The vision on August 17th was 5/10 with a −2.00D. sph. On August 20th the vision had dropped to 2/60 and the intraocular pressure to zero. The optic nerve head was edematous and the retinal blood vessels were tortuous. The slitlamp showed only a slight aqueous flare. Three days later the vision seemed brighter, and with a +3.00D. sph. it was found to be 5/30. The tension was 2 mm. Hg. On September 4th the vision, with +2.00D. sph., had improved to 5/7.5. The tension

was 13 mm. Hg, and the disc edema had largely subsided.

On October 31, 1942, the right eye was quiet. There was a generalized redness due to the presence of numerous large vessels in the conjunctiva. Vision, right eye, was 5/10; with +1.00D. sph. ⊂ +1.00D. cyl. ax. 105° vision was 5/7.5; the tension, 18 mm. Hg (Schiötz).

On December 23, 1942, the eye was still quiet, the cornea clear, somewhat less red but still injected. Vision, without correction, was 5/10+; with +1.00D. sph. vision was 5/7.5. The tension was 16.5 mm. Hg.

The ophthalmoscope revealed clear media. The disc showed a large, shallow, glaucomatous cup. There was a Bjerrum scotoma extending from the blind spot above the macula. The peripheral field has been unchanged for some time.

Comment

From the number of theories that have been advanced to account for the associated glaucoma, it is evident that the exact cause is not known. Beltman[8] assumed that the thin-walled veins in the choroid, in which the blood pressure was abnormally high, allowed the transudation of excessive amounts of fluid. He also thought that the absorption was diminished. Elschnig[9] believed the glaucoma was due to the plethoric condition of the choroidal vessels. Yamanaka's[10] conception was that there were two causes; namely, an increase in the number and dilatation of the choroidal vessels, and malformation of the chamber angle with an insufficient outflow of aqueous. Tyson[11] suggested that the anterior chamber angle is blocked by a "plasmoid" aqueous resulting from changes in capillary permeability. Mehney[12] made a chemical analysis of the aqueous in his case and found the protein content to be 0.032 percent as compared with a normal of 0.02 percent.

Pathologic examinations have been reported in 15 eyes. In all cases the intraocular capillaries have been dilated; in 12 there were angiomata of the choroid, and in 2, angiomata of the iris.

In the case reported here, certainly the vascular anomaly was responsible for an abnormal circulation of the globe, resulting in a disorganization of the normal fluid-traffic in the eye. It was the belief of the senior author that the destruction of these supernumerary telangiectatic vessels might help to restore the circulation of the globe to a more normal state. In addition, the destruction of the ciliary body following cyclodiathermy, as outlined by Vogt,[7] or by Albaugh and Dunphy, nonperforating,[13] would result in a reduction of the amount of aqueous formed, and aid in controlling the ocular hypertension.

In this case there were no symptoms suggesting intracranial changes, such as reported by Pincus.[14] However, no roentgenograms of the skull were made.

Summary

A case of hydrophthalmos, associated with nevus flammeus, treated by cyclodiathermy is here reported, but it is too early to draw any conclusion as to the effectiveness of this procedure even in this one case.

Carleton Building.

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ROENTGENOGRAPHY OF EXOPHTHALMOS WITH NOTES ON THE ROENTGEN RAY IN OPHTHALMOLOGY*

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Part I

INTRODUCTION

Ophthalmology was one of the first branches of medical science to utilize the roentgen ray when Clark[1] in 1896 demonstrated its usefulness in revealing foreign bodies in the orbit; nevertheless ophthalmology seems to be one of the last specialties to appreciate the full worth of this valuable aid to diagnosis. Many ophthalmologists appear to be as unfamiliar with its many uses as with its limitations. On the one hand, roentgen-ray studies frequently are employed only when the clinical problem is obscure—as a last resort, so to speak—and, on the other hand, they are frequently disregarded as a diagnostic aid even when their use is clearly indicated by the clinical findings. The general opinion among ophthalmologists is that the roentgen ray is occasionally revealing and helpful, but that it is not sufficiently important to be given special attention or to be included in the curricula of medical schools or in the training of resident physicians. After devoting nine years to diagnostic cranial roentgenology (studying and individually reporting upon all the films of eye patients seen in a busy medical center) in conjunction with the practice of ophthalmology, the writer is convinced that the roentgen ray occupies a most important and indispensable place as a diagnostic modality in the practice of ophthalmology; that eye physicians in general do not appreciate its importance; and that it deserves far more attention than it has received up to the present time.

It has been largely through the coöperation of the specialist with the roentgenologist that practically every branch of medicine has benefited from the exploitation of the roentgen ray. Encephalography, ventriculography, urography, chole-

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cystography, and many roentgen techniques for the study of gastro-intestinal conditions were first suggested by specialists in fields other than roentgenology; and neurology, gastroenterology, urology, and orthopedic surgery owe a large part of their phenomenal progress to the science of roentgenology. With a number of important contributions that have been made, its field of usefulness in ophthalmology has become greatly extended, and its value in diagnosing the presence of and locating intraocular foreign bodies is no longer its most significant application in ophthalmic practice. Skull roentgenography has made rapid advances since Caldwell,[2] in 1906, described a good position for revealing the paranasal sinuses, and incidentally the orbits, with a minimum of superimposed bony structure and distortion.

The roentgenogram or film is a record of shadows of various structures or parts of the anatomy. As such, it possesses the faults and limitations of shadows that are not mere silhouettes of contours, but records of various densities of tissue that have been penetrated by the ray. From the production of the films, which requires scrupulous care and the application of a knowledge of anatomy and physics, to the study and interpretation of the recorded shadows, misleading similarities, artifacts, and omissions may occur and may defeat the purpose of the examination. In the very nature of things, therefore, the interpretation of films is difficult and subject to error, and for this reason the clinician will never be in a position to usurp the role of the trained roentgenologist, except perhaps in sharply limited fields. Through association with the roentgenologist, and from the study of films of his own patients, however, the ophthalmologist may acquire a considerable degree of competence that is most desirable in view of the serious responsibility that is frequently involved. In all fairness to the patient no treatment should be undertaken before a study of the positive roentgenographic findings has been made by the ophthalmologist himself. No reports, however minutely detailed, can take the place of actual inspection of the films.

As the clinician should see the films, so should the roentgenologist see the patient. This practice gives life to inanimate recordings and serves to prevent at least gross errors in or inadequate interpretation. Although this procedure may not be feasible in all laboratories, its desirability is obvious. When a patient comes for an X-ray examination, the roentgenologist's diagnosis of the existing condition, and not merely a report on a few films, is desired. When he sees the patient, he need not depend on the requisition—which is all too frequently only a signed printed form—but can proceed with the study in his accustomed way, making films of all the different positions necessary in order to further his interpretation of the case. Thus failure to secure films of the right position of the skull in a given study may result in a negative report. This is especially true of roentgenography of the orbit.

In ophthalmic literature relatively few reports of cases in which positive roentgenographic changes in the orbits were demonstrated have been published. This suggests that such findings are rare, and in view of the fact that more frequent mention of negative results is made, may lead to a misconception of the value of the roentgen ray in ophthalmology—this in spite of the publication of two excellent monographs on the subject, one in German[3] and one in French,[4] which should have commanded attention. These treatises, by describing a representative cross section of cases, give a good general view of the application of roent-

genography in ophthalmology. They do not, however, indicate its full value in the study of any one subject; for example, exophthalmos. This could be accomplished only by determining the percentages of positive and pathognomonic findings in a large number of cases in the category in question. The present study was undertaken for the purpose of measuring this value with respect to exophthalmos. Only such roentgenographic material from the files of the Institute of Ophthalmology of the Presbyterian Hospital of New York, which has been personally studied and reported upon by the writer, has been included. Every effort was made in each case to reveal the maximum possible with the roentgen ray, and to that end several new techniques[5, 6] were developed.

The scope of roentgenography in ophthalmology

The employment of roentgenography is indicated in the following ophthalmologic conditions:

Exophthalmos.
Visual-field changes suggesting a lesion of the central visual nervous apparatus.
Optic atrophy.
Papilledema and optic neuritis.
Oculomotor paralyses.
Trauma in the orbit and enophthalmos.
Intraocular or intraorbital foreign bodies: their diagnosis and localization.
Diseases of the lacrimal drainage system.
Intraocular tumors.
Question of focal infections.

Exophthalmos. Of all the indications for roentgen-ray study, exophthalmos is probably the most important, due to its relative frequency, its menace to vision, and the fact that it is often an indication of a threat to life itself. Aside from operation, the roentgen ray is the only means at our command that is capable of disclosing in a high percentage of cases the cause of the displacement of the eye.

Visual-field changes. Obscure visual-field changes, peripheral or central, demand roentgen-ray studies of the skull and orbits. Clear-cut quadrant defects and hemianopias always indicate the necessity for roentgenographic study, but intracranial lesions—inflammatory, neoplastic, or vascular—frequently do not produce suggestive field changes.

Optic atrophy that cannot be explained by the local eye findings is invariably an indication for roentgenography. The possibility that a lesion of the central visual nervous apparatus may coexist with an ocular disease and lead to atrophy should be appreciated. Thus, for example, a pituitary adenoma may be present with glaucoma. Although many of the innumerable causes of optic atrophy are covered by roentgen-ray study, its percentage of success in elucidating these cases is not so great as it is in exophthalmos. If plain films are not helpful, and the clinical findings warrant it, encephalography or ventriculography should be considered.

Papilledema and optic neuritis. Papilledema, whether unilateral or bilateral, is always an indication for X-ray studies of the orbit and skull. The unilateral condition may be produced by stricture of the optic canal. In addition to neurologic examination, intracranial air studies may be necessary to locate the lesion.

Optic neuritis is not always distinguishable from papilledema and should be investigated in a similar manner. The question of focal infection also arises; thus the writer has seen three cases of optic neuritis with loss of vision result from sphenoiditis, in which the recesses of the sphenoid extended around, or partially around, the optic canal.

Oculomotor paralyses are also sugges-

tive of orbital lesions, and more especially of intracranial lesions, and should be studied roentgenographically.

Trauma in the orbit and enophthalmos. Fracture of the orbit can usually be diagnosed clinically, but the extent of the fracture cannot be determined without the aid of roentgenograms. These should always be made, if only to avoid possible medicolegal consequences. In every case of traumatic enophthalmos studied in our laboratory, fracture of the orbit has been demonstrated by roentgenography. Enough evidence has been accumulated to show that enophthalmos is due to fracture, although in many cases there is no external evidence of the break in the continuity of bone. Frequently the force of the blow strikes the eyeball directly, and is transmitted by it to the floor, and perhaps to the nasal wall of the orbit, fracturing these structures, which are thin and relatively fragile. As a result, the floor of the orbit may be fragmented or depressed into the antrum beneath, allowing some of the orbital contents to prolapse to some degree into this sinus. The capacity of the orbit may be otherwise increased by medial dislocation of the lamina papyracea which compresses the ethmoid cells. Isolated fracture of the roof or lateral wall has never been observed by the author to have been produced in this way.

While many cases of fracture of the orbit and a considerable number of posttraumatic optic atrophy were studied, only two instances—and those not incontrovertible—of fracture of the optic canal have been observed in our laboratory. This infrequence with which fracture of the orbit is demonstrable by roentgenography has been variously explained on the basis of inadequate technique.[7] In order that a fracture of the somewhat delicate bone of the canal be revealed on films, separation of fragments must occur, as was the case in the few instances reported in the literature.[3, 4, 7] After a study, in the Army Medical Museum, of the extensive collection of skulls of various forms of war injuries in which the optic canal was invariably spared, even in those cases in which much bone was shattered, it is the writer's belief that fracture of the optic canal occurs very infrequently.

Intraocular and intraorbital foreign bodies: their diagnosis and location. Modern methods of roentgenography have made the diagnosis and localization of intraocular or intraorbital foreign bodies comparatively simple and accurate. The bone-free films suggested by Vogt[8, 9] are capable of revealing minute bodies of almost any density other than that of the tissues of the eye and lids, and should be used in every examination for foreign material. Even the shadows of the cilia may be seen in these films. They are especially serviceable in studying opacities of the cornea for calcium, and in determining the presence of small fragments of glass in the anterior segment of the eye or in the lids. The sphere of usefulness, however, of these films is determined by the prominence of the eye, for only those parts of the globe as are anterior to the margin of the orbit are recorded on the film. If the eye is rotated, deeper structures may be examined. It is possible, by changing the position of the source of the ray and the film in reference to the limbus of the cornea, to localize accurately a minute body which could not be shown on regular films.

The localization of radiopaque foreign bodies with the especially adapted contact glass which was introduced by Comberg[10, 11] is an accurate, rapid, simple, and inexpensive method. In our laboratory it has been modified[6] to eliminate one source of error, and this, we believe, has improved the technique. The inflation of

Tenon's capsule with air effectually indicates in marginal cases the true position of a foreign body when the question arises as to whether the body is in or outside the eyeball.

Diseases of the lacrimal drainage system. The lacrimal drainage system lends itself readily to roentgenographic study with contrast media, and considerable information of surgical value may be obtained from its use. The strictures of the canaliculi, sac, or nasolacrimal duct may be revealed. The presence of diverticuli of the lacrimal sac has been demonstrated. The surgeon would do well to make use of roentgenography before planning operative procedures on any patient with lacrimal-sac disease.

Intraocular tumors. One of the most recent extensions in the field of application of the roentgen ray in ophthalmology has been in the study of intraocular tumors. In a previous report[12] the author has shown that the calcium granules found in retinoblastoma may be disclosed by the roentgen ray and be used to differentiate the tumor from conditions that simulate it. Sarcoma of the choroid cannot be diagnosed by roentgenography, but extrabulbar extensions may produce changes in the orbit that will give suggestive findings on the films.

Focal infections. Perhaps roentgenography is practiced more often in the diagnosis of focal infection than for any other purpose. The sinuses, the teeth, and the chest are the structures most commonly investigated. More reports are issued showing negative findings than positive findings, but the frequency with which positive findings are seen, whether or not they can be regarded as foci responsible for the ocular inflammation, amply justifies the practice. In our experience with positive findings of periodontoclasia, apical-root infection, and devitalization, the teeth are far more frequently incriminated as the source of eye disease than are all other structures combined.

Orbital roentgenographic technique

In roentgenography the correct technique is of primary importance. More failures can be ascribed to the lack of it than to inexperience or carelessness in interpreting the results. The diagnostic aid given to the roentgenologist or ophthalmologist by the films is directly in proportion to the quality of the film. To the interpreter of films, moreover, a knowledge of technique is quite indispensable. One can easily be misled by imperfect aligning, or, because of poor positioning, one may overlook an important variation. Deficiency in calcium content, for example, may be concealed by faulty exposures, or the condition may be simulated when, in fact, it does not exist. Detail, contrast, and density of films, in addition to correct positioning and processing, are points for the technician to work out; it is largely upon him that the success or failure of the study depends.

Since the making of the film is in the hands of the technician, his training is a matter of great concern. He must learn to sense his own importance, to feel that he too is enlisted to help the patient, and not merely to satisfy the demands of the physician. He must endeavor to obtain the clearest films possible, and to this end, when there is need for improvement, he must repeat his projections. The technique calls for much judgment and skill, as well as for a knowledge of the physics of the roentgen ray. This is especially true in orbital and skull roentgenology.

The one feature of outstanding importance in the making of roentgenographic films is to prevent the distortion which results from poor centering, aligning, or

positioning of the part being roentgenographed. For the interpretation of films of the sinuses, orbits, bones of the face, and calvaria, symmetry of projection of the parts of the anatomy on the film is essential. This applies to all sagittal-plane projections, regardless of the position. The roentgenologist seeks always to compare the two sides, one with the other, for in this way he is enabled to recognize minute variations from the normal. A lack of symmetry may be misleading, or may even render the films worthless. Occasionally, of course, correct results cannot be attained because of asymmetry of the skull itself.

For roentgenologic study of the orbits films specifically made for this purpose must be used. Ordinary films of the skull fail properly to reveal the orbits and their component parts. In the study of such orbital conditions as exophthalmos, it is frequently necessary to have films of the entire skull. This does not mean that more films be made, but, rather, that the skull be fully shown on those films that are taken. For a complete roentgenographic orbital study the following films, views, or projections are required: (1) Caldwell view, (2) Waters view, (3) lateral view, (4) views of the optic canals, and (5) basal views. Other and more special views may be made if necessary. All should be in stereoscopic projection, and to increase the detail, the orbits may be sharply coned when the films are made. Each of these routine projections reveals certain parts to the best advantage, and any one of the films may succeed in disclosing a lesion that may not be evident in any of the others.

The Caldwell view is perhaps the most important. In this frontal projection the orbits are clearly defined, with the petrous portions of the temporal bones superimposed on the superior maxillae. This minimum of superimposed structure enables one to compare the orbits and their component parts most advantageously. In this view the margins, walls, superior orbital fissures, sphenoid ridges, and the lines of the temporal fossae are all well displayed. In addition, the neighboring frontal and ethmoid sinuses and the nasal fossae are distinctly shown. Measurements are best made on this film, but allowance must be made for the distortion which results from the slightly oblique angle at which the rays strike it.

The Waters view is made with the head in the nose-chin position, in order that the shadows of the petrous bones will be thrown below, and not on, the upper maxillae. The antra then are above, and are clearly revealed. Above the antra are the orbits, distorted by the inclined position. This postero-anterior view is useful for comparing, at a different angle, the parts of the orbits mentioned in the foregoing paragraph. In it the floors and roofs are particularly well seen, with the zygomatic bones and temporal arches sharply defined.

The lateral view is the least helpful one in an examination of the orbits, but is most valuable in showing anterior and posterior relations and hence is indispensable.

The optic canals are probably the most important bony structures to the ophthalmologist, and films of these canals are an absolute necessity in every orbital study. Variations that cannot be found in any other view occasionally appear in these, and may suggest the diagnosis. Because of their inclined position near the center of the skull it has been difficult to project them accurately on films. More than 30 different methods for filming these canals have been advocated. The technique devised in our laboratory, which has been fully described in a previous report,[5] has given entire satisfaction. A simple device is employed, which renders filming of the

canals no more difficult or time-consuming than other skull techniques. This method permits the projecting of the canals on the films accurately, symmetrically, and in true contour, in such a way that the views can be reproduced. Symmetry of projection must be secured if minute variations are to be recognized, and both canals must be roentgenographed simultaneously under the same conditions and without movement of the patient's head between exposures.

The basal view is not always required, but lesions of the middle fossae and sella turcica frequently produce changes that are visible in these films. Asymmetry of the orbits is usually well shown, and the basal films may be the only ones that reveal asymmetry of the middle fossae. This view is one of the most difficult for the technician to make satisfactorily. Success depends in part upon the flexibility of the patient's neck and upon the elevation of the patient's body above the level of the roentgenographic table to compensate for lack of extensibility of the cervical spine.

Finally it must be stated that it is not always possible to secure perfect roentgenograms. Much depends upon the patient's coöperation and upon his appreciation of what is desired of him. If he is nervous or exhibits a body tremor, the films will show movement and poor detail; if the patient is a child, general anesthesia may be necessary. If the bones are deficient in calcium density or have massive hyperostoses, films of high grade should not be expected.

Roentgenographic orbital anatomy

A reorientation of one's knowledge of the anatomy of the skull is required in order to understand and interpret its many structures when they are portrayed in the two-dimensional medium of the roentgenogram. This is rendered easier by the use of stereoscopic views. A thorough knowledge of variational anatomy is particularly important, since individual anatomic differences are nowhere more apparent than in the osteology of the skull. Variations occur, depending on age, sex, and race, and only as the result of experience can an appreciation of the range of normal variation be gained.

Variations of age, sex, and race. In films of babies, because of the small amount of calcium in the bones, orbital details are not well defined, although the essential parts of the orbits can be easily identified. The orbits are large in proportion to the size of the bones of the face, and small in proportion to that of the bones of the vault. The margins are sharp, and the orbital entrance, which is round in very early life, gradually becomes oval and then rectangular as the orbits are encroached upon by the developing neighboring structures; that is, the nasal fossa and the ethmoid cells, the frontal lobe of the brain, the calvaria, and, according to anthropologists, the muscles of mastication. The optic canals of babies, as revealed by our technique, are small and piriform rather than circular, with definite rounded grooves below through which the ophthalmic arteries probably pass. The canals grow rapidly, assume the rounded form, and seem to attain approximately adult size at the early age of from three to five years. The orbit itself, most likely, does not cease to grow until some time after puberty. Removal of an eye, however, checks the growth of the orbit, and in the succeeding years, whether or not an implant has been used, the cavity becomes smaller in all its diameters, the concave walls become flattened and the convex walls grow more convex, the marginal diameters become smaller, the optic canal becomes smaller and oval in contour, and facial asymmetry becomes apparent. The

degree of change is dependent upon the stage of growth that was attained before enucleation took place. The adult orbit also undergoes a change in structural contour after enucleation has taken place, becoming smaller with the passing of time.

In the aged, contrast in the films is not as marked because of the diminished calcium content or atrophy of the bones. Patients who have been ill and inactive over a long period of time and those who have parathyroid disease also show a reduction of the calcium content. In all these classes of patients structural detail is not sharp. In the aged, suture lines are obliterated by fusion, but their positions are easily detectable.

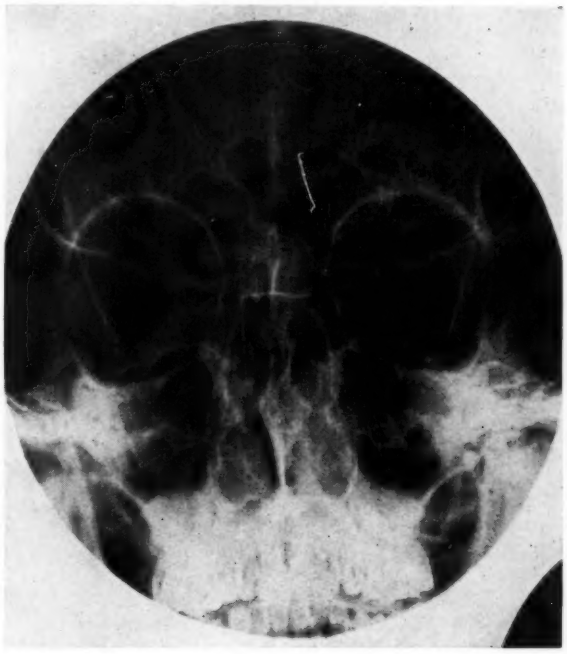

Fig. 1 (Pfeiffer). Roentgenogram of normal orbits (the Caldwell view).

Sexual differences are especially demonstrable in films of the orbits. The sturdier construction of the male is apparent in the stronger, more rounded, and prominent supraorbital ridges, more sharply angulated marginal configurations, denser bone, and pointed lateral angular processes of the zygomas. The slender angular processes associated with the more delicate architecture of the

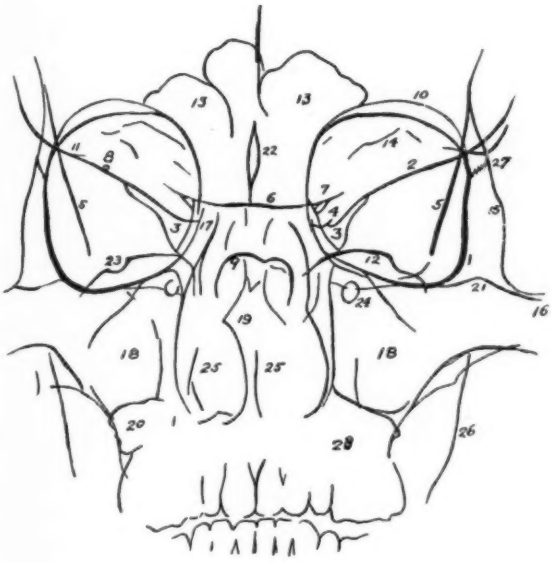

Fig. 2 (Pfeiffer). Anatomy of the Caldwell view of the orbits. 1, Margin of orbit. 2, Sphenoid ridge. 3, Superior orbital fissure. 4, Anterior clinoid process. 5, Temporal line. 6, Squamous portion of sphenoid. 7, Optic canal. 8, Meningeal foramen. 9, Sphenoid sinus. 10, Roof of orbit. 11, Anterior fossa. 12, Floor of orbit. 13, Frontal sinus. 14, Impressiones digitae. 15, Angular process. 16, Temporal arch. 17, Ethmoid labyrinth. 18, Maxillary sinus. 19, Nasal septum. 20, Unerupted molar tooth, 21, Ridge of petrous bone. 22, Crista galli. 23, Infra-orbital groove. 24, Foramen rotundum. 25, Nasal fossa. 26, Ramus of mandible. 27, Fronto-zygomatic suture. 28, Superior alveolus.

female orbits are an invariable characteristic of the sex. These processes are well delineated in the optic-canal films, and their character is probably the best osteologic indication of sex.

In addition to the variations due to age and sex, striking racial variations are demonstrable. The writer has found it quite impossible, however, to determine the race of patients from orbital indices because of the great variations within the white race itself. For the determination of orbital types, measurements of the orbits can best be taken from the Caldwell projection, but must always be considered as approximate and of only relative value (figs. 1, 2). The orbital index can be determined from measurements taken from the same points as in dry specimens, but these points are not as well defined.

The orbital entrance. On the film the orbital entrance appears as an incomplete ring—as, indeed, it is anatomically—with the defect medial and superimposed on the ethmoid bone. In the young the zygomaticofrontal suture also interrupts the ring before it is well fused, and, hence it has been mistaken for fracture. The supraorbital notch may also be apparent. In viewing postero-anterior films the lines projected by the roofs should not be confused with the superior margin.

The lateral wall. The lateral wall, the strongest of the four walls, is the one that is revealed best in the roentgenograms. Its lack of uniformity of thickness is well shown. Dividing the anterior two thirds of the wall is a dense line slanting slightly from the vertical; this is the shadow of the cortical bone of the temporal fossa projected on the film, and is seen best in the Caldwell view. This line may be termed the "temporal line," and can be traced upward to the vault on each side. It should be observed in each orbit, and one side compared with the other as to symmetry. The wall on the medial side of this line is quite thin, and can be well demonstrated by transilluminating the dried skull. Except for the orbital tubercle and a shallow concavity just posterior to the margin, it is flat. The important superior orbital fissures are distinctly revealed, and should always be examined. These fissures assume a great variety of shapes and are frequently asymmetric. The small meningeal foramen may be seen lateral to the tip of the fissure, whereas the foramen rotundum is inferior to the medial broad segment. The inferior orbital fissures are difficult to distinguish except in basal views.

The roof. The smooth domelike roof of the orbit may be fully revealed for study, but there is no part of the structure that is so misleading in roentgen diagnosis. At times it is quite smooth throughout, but more frequently digital impressions (impressiones digitatae) are present, and may be pronounced. The irregular shadow produced by these is deceptive. Supraorbital recesses from the frontal and ethmoidal cells are common and at times may be very extensive. In some orbits the bones of the roof are exceedingly thin, and dehiscences may be found, whereas in others they are quite thick. When the parietal bones are thick and porous, their superimposed shadows may change the effect on the appearance of the bones of the orbits. The sphenoid ridges serve to demarcate the roofs from the lateral walls, and should be examined for symmetry and thickness in all orbital films. Portions of the anterior clinoid processes which form the medial ends of the ridges can be well seen in the Caldwell projection, but the optic canals, because of their oblique positions, are invisible.

The medial wall. With the possible exception of the floor, the medial wall is the weakest and is the least well-defined structure in films. In the postero-anterior

views it can be recognized as thin lines running from the posterior crest of the lacrimal groove to the side of the body of the sphenoid. It can also be distinguished

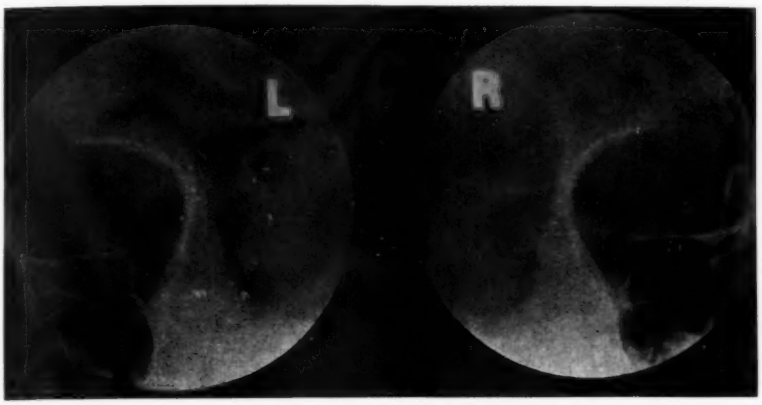

Fig. 3 (Pfeiffer). Roentgenogram of normal optic canals. One of a pair of stereoscopic films.

in the basal views. Dehiscences of the lamina papyracea cannot be seen. It is very difficult, if not impossible, to demonstrate the fossa of the lacrimal sac. The lacrimal drainage system can be studied roentgenographically only through the use of contrast media.

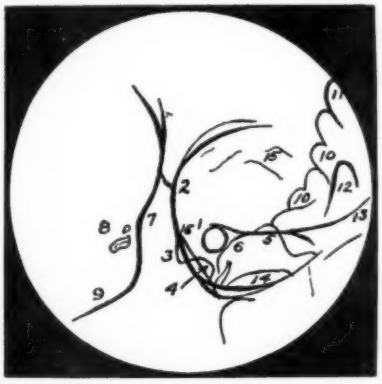

Fig. 4 (Pfeiffer). Anatomy of the optic-canal projection. 1, Optic canal. 2, Fronto-zygomatic suture. 3, Anterior clinoid process. 4, Superior orbital fissure. 5, Squamous portion of sphenoid. 6, Sphenoid sinus. 7, Angular process. 8, Pineal body. 9, Temporal arch. 10, Ethmoid cells. 11, Frontal sinus. 12, Crista Galli. 13, Roof of other orbit. 14, Floor of sella turcica. 15, Digital impressions. 16, Orbital tubercle.

The floor. This is the shortest of the four walls and can be easily studied in roentgenograms. The posterior convex portion, which is an upward extension of the maxillary sinus, should be examined in both the Caldwell and Waters projection, and one side compared with the other as to symmetry. The anterior concave portion of the floor is not quite so clearly demonstrable. Structurally, the floor is very thin, and is the most common site of fracture. The intraorbital groove or canal can be seen running posteroanteriorly across the floor.

The optic canals. Special films are required to show the optic canals, and are necessary in every orbital study (figs. 3, 4). When these films are properly produced, the canals are well revealed in true contour—usually in the lower outer quadrants of the orbits. Among the adjacent structures that can be identified are: the sphenoid sinuses, the inferior roots of the lesser wings of the sphenoids and small portions of the supraorbital fissures below, the adjacent anterior clinoid processes, the superior roots of the lesser

wings of the sphenoid, and the tuberculum sellae. In addition, the walls of the orbits can be recognized as well as the ethmoid cells in oblique positions, the margins of the orbits, and various other parts. Perhaps no orbital structure varies as much in the films as the optic canals—each pair of canals differs from every other pair. The average canal is circular in contour and about 5 mm. in diameter; it may, however, be slightly oval or even piriform in outline. Normal canals may be as small as 4 mm. or as large as 7 mm. in diameter.[15, 16, 17] Occasionally the anterior or orbital opening of the canal is circular, whereas the posterior opening is oval, the upper margin appearing thin and encroaching upon the lumen posteriorly. This thin upper wall or roof of the canal has been reported to be an indication of increased intracranial pressure,[14] but it has also been observed in normal skulls. Asymmetry of the canals is rare, and may be dependent on the size, the contour, or the direction of the axes; it must not, however, be accepted as existing in fact until asymmetry due to faulty technique has been carefully ruled out.

Variations in the optic canals. The great number of normal variations that may be present in the canals may be grouped as follows:

1. Variations in the position of the ophthalmic artery. In the writer's experience separate canals are found in approximately 1 out of 400 skulls. More frequently grooves are present in the floors of the canals to accommodate the ophthalmic artery. In several cases minute canals were found immediately below which probably transmitted branches of the ophthalmic arteries.

2. Variations in the positions of the sphenoid sinuses with relation to the canal. Recesses of the sphenoid sinus not uncommonly extend into the upper or lower root of the lesser wing of the sphenoid. Occasionally these recesses extend entirely around the canal, so that the canal can be said literally to pass through the sphenoid sinus.

3. Variations in the position of the internal carotid artery. This artery may run quite far forward under the canal and upward to reduce the inferior root of the lesser wing or the floor of the canal to a very thin ridge of bone. The formation of clinocarotid canals formed by the fusion of the tip of the anterior clinoid processes with the middle clinoid is not an uncommon finding, and may cause misinterpretation of the canals themselves. A calcified internal carotid may be recognized as a ring slightly smaller and immediately below the canal. A curious pseudocanal may be formed by the cortex of the anterior clinoid adjacent to the optic canal.

4. Variations in the shape of the skull and orbits. Development of the cranium has probably the greatest influence upon the orbit and determines its size and shape. This is true also of the optic canals. Affection of the sutures or their premature closure may occur and any form or degree of change may result. In these conditions all types of optic canals, from the small and stenotic to the sharply angulated, may be encountered. As there is no typical shape of the skull in craniostenosis, no characteristic variation of the optic canal is found in this condition.

Other demonstrable features. The size and capacity of the normal orbit vary greatly and will be discussed under the subject of exophthalmos and pathologic changes in the orbit. Within the orbits certain shadows of soft tissues can be distinguished. The interpalpebral fissures can easily be identified, especially if the eyes were open at the time the exposures were made. At times the outlines of the

tarsal plates of the upper one in particular, can be seen. The eyeball cannot be recognized except by the use of contrast media. If Tenon's capsule is inflated the globe may be clearly delineated. Portions of the anterior ocular adnexa and the anterior segment of the globe can be shown in bone-free films made after the method of Vogt.[8, 9]

Films taken especially for the purpose of displaying the orbits reveal the paranasal sinuses advantageously, and affections arising there may readily be detected and their relationship to, and possible influence on, the orbit and its contents be disclosed. Behind these the sella turcica and its immediate environs can be studied.

Suggested routine for roentgenographic study of the orbit

In interpreting films of the orbits it is essential that the observer have a conception of the clinical picture and problem in mind, together with a definite method or routine for study. For example, he should—

1. Note the symmetry of the orbital margins, measure the indices, and type the orbits as mesoseme, microseme, or megaseme.
2. Note and observe for symmetry the sphenoid ridges, the anterior clinoid processes, the superior orbital fissues, and the temporal lines.
3. Compare the orbital walls for symmetry as they are revealed in the various projections—first the lateral, then the superior, then the medial, and finally the inferior.
4. Note normal variations and pathologic changes.
5. Scrutinize intraorbital-soft-tissue shadows in order to detect any increase in soft-tissue density.
6. Look for evidence of increased intraorbital pressure.
7. Examine the optic canals closely and compare them for symmetry; note normal variation and pathologic change, and identify the neighboring structures.
8. Examine the paranasal sinuses—first the frontals, then the ethmoid, maxillary, and sphenoid sinuses.
9. Study carefully the sella turcica—its component parts and its neighboring structures.
10. Prepare additional skull films if they should be necessary in order to give the clinician a complete report of the orbits and cranium.

Pathologic changes in the orbit

The pathologic variations to which the orbit is subject are so numerous and so extreme in degree as to be almost unbelievable. The capacity of the orbit may be found to be less than one fourth or more than twice the normal. The orbital entrance may be circular, rectangular, or irregular in shape, with destruction of the bony margin. It may vary in depth from one half to nearly twice the normal of De Wecker and Lagrange (40 to 50 mm.[13]). The angles of the walls, the entrances, and the long axes may vary widely. These variations may affect one or both orbits, and if present, will in any case greatly influence the position of the eye or eyes.

The variations and changes from the normal which are associated with or produced by the causes of exophthalmos and which may be recognized in the roentgenogram are numerous and differ in character and effect. They will be discussed under the following heads:

1. Increased soft-tissue density.
2. Increased intraorbital pressure.
3. Fossa formation or indentation of bone.
4. Dehiscences.
5. Invasion and erosion.

6. Hyperostosis.
7. Deformity of the optic canal.
8. Miscellaneous.

1. *Increased soft-tissue density.* Any increase in the soft-tissue content of the orbit may be recognized in the roentgenogram, for the shadow produced on the film is lighter, due to the greater absorption of the roentgen ray. Primary or metastatic neoplastic tissue is one of the primary causes of increased soft-tissue density, but the latter may also be produced by hemorrhage into the orbit or by edema associated with inflammation or trauma. Its recognition is useful, as it indicates the orbit involved. Collections of air or gas in the orbit appear as diminished density; that is, present a darker shadow.

2. *Increased intraorbital pressure* refers to the increase in the capacity of the bony orbit produced by expanding intraorbital lesions. This condition is analogous to the change that takes place in the calvaria due to increased intracranial pressure. The roentgenographic appearance is that of a larger orbit, with changes in the contours and density of the walls. The orbital margin may remain unchanged. The concave walls become still more concave, and the convex ones grow less convex or even become concave. The earliest evidence appears in the nasal wall. The somewhat convex lamina papyracea becomes flattened and later is seen to be quite definitely concave, compressing the ethmoid cells. The posterior convex portion of the floor later undergoes a change in contour. The concave roof and lateral wall may become noticeably more concave. The increased intraorbital pressure at the same time produces thinning or atrophy of the bone. The nasal wall may disappear almost entirely, and the roof may become paperlike in thinness and develop dehiscences or one large defect in which the bone completely disappears. In well-marked cases the increase in capacity of the orbit may be shown definitely by mensuration.

That the orbit should attempt to accommodate itself to its increased content is consistent with the law of adaptation, which calls for an adjustment of the organ to whatever function it is called upon to fulfill. At first thought it may appear astonishing that the orbit, which is open in front and closed by the tarsal plates, the canthal ligaments, the orbital septum, and the eyeball, should undergo this profound change in its bony architecture. The tarsal plates and canthal ligaments, however, are firm structures and are capable of offering considerable resistance to proptosis of the globe. Similar effects on bony structures are produced by lesions in other parts of the body—for example, in cases of pituitary adenomata the neoplasm may grow downward through the floor of the sella turcica as the line of least resistance, because of the resisting diaphragma sellae; a subdural hematoma may produce enlargement of the middle cranial fossa (case 32); aneurysms readily erode bone; increased intracranial pressure produces atrophy of basilar bony structures.

In cases of hydrophthalmos the orbits are larger than normal. In one case of unilateral hydrophthalmos the difference in the sizes of the orbits was clearly apparent. In several cases of unilateral myopia of extreme degree the orbits of the myopic eyes were larger than normal. Any growing tumor of the orbit may produce roentgenographic evidence of increased intraorbital pressure if sufficient time has elapsed. Less time is required to produce the change in young, growing patients than in adults. In the case of a new growth in the orbit of a child, as, for example, in case 28, a demonstrable change

may be observed in a few months' time. A similar change in an adult might not be manifest in from one to several years, the length of time depending in part, of course, upon the rapidity of growth of the tumor. In one patient in this series (case 12) aged 46 years, with an exophthalmos of 6 mm. of 2½ years' duration induced by a hemangioma, a difference in the size of the orbits was most apparent. The tumor most commonly producing this change is the hemangioma, but it has also been observed in cases of neuroma, meningioma, sarcoma, carcinoma of the lacrimal gland, and neurofibroma.

A condition opposite to that of increased intraorbital pressure occurs following enucleation. Thus, the orbit shrinks in size, and the earlier the age at which the enucleation is performed, the greater is the reduction in the size of the cavity and the sooner the change becomes manifest.

Fossa formation or indentation of bone. Congenital tumors or cysts of the orbit may be associated with fossae in the bone, which, when observed in the roentgenogram, indicate the congenital nature of the lesion. In the fossa the cortex of the bone extends uninterruptedly, and this fact differentiates a fossa from a destructive process of the bone. Dermoid or epidermoid tumors or cysts are the most common lessions associated with the presence of fossae. In a case of mixed tumor of the lacrimal gland (case 24), a deepening of the lacrimal fossa by 5 mm. pointed to the lacrimal gland as the cause of exophthalmos and indicated the congenital nature of the tumor. In another case the fossa in the roof of the orbit just posterior to the margin was caused by a hemangioma.

4. *Dehiscences.* Hiatuses, or through-and-through defects of the bony structure of the orbit, may be produced by a variety of diseases. Congenital dehiscences are rare. According to Whitnall, the most common are those affecting the lamina papyracea; these were never observed in our laboratory. Dermoid or epidermoid tumors may be associated with characteristic dehiscences. The openings are sharply circumscribed, show an increased density of the surrounding bone, and have perfectly smooth margins—evidence of the congenital nature of the lesion. Retention cysts of the paranasal sinuses, particularly those of the frontal and ethmoid cells, are the most frequent cause of openings in the walls. In well-prepared films these dehiscences can invariably be distinguished. Xanthomatosis and metastases involving the bone of the orbits produce sharply, though irregularly, circumscribed defects which are characteristic of erosion.

5. *Invasion and erosion,* or osseous destruction, are characterized roentgenographically by irregular loss of bone, which produces an ill-defined, irregular opening, and, in cases in which the bone is thick, as at the margin of the orbit, definite loss of cortex. In several cases of carcinoma of the nasal fossa extensive destruction of the ethmoid labyrinth and nasal wall of the orbit was observed. In one case in which carcinoma developed in the sphenoid sinus there was destruction of part of the optic canal and adjacent nasal wall of the orbit. In two cases of basal-cell epithelioma of the eyelids in which the growth had invaded the orbit there were erosion and loss of bony substance at and adjacent to the margin. In one case a very extensive defect in the lateral wall of the orbit was produced by rhabdomyoma. Cases of myeloma, neuroblastoma, xanthomatosis, and osteochondrosarcoma were observed to produce extensive destruction of the orbit.

6. *Hyperostosis* of the orbit may occur in connection with a number of conditions, but the most common cause is meningioma[18, 42] arising from the sphenoid ridge; this condition will be discussed later in connection with this tumor.

In one instance (case 25), an extensive overgrowth of bone of the anterior roof and margin of the orbit over and around the fossa of the lacrimal gland was produced by a mixed tumor of this structure. Marked thickening of the lateral wall of the orbit below the superior orbital fissure was caused by a lymphoepithelioma that had its origin in the pharynx (case 23). Paget's disease and osteitis fibrosis cystica are additional causes of thickening of the bony structure of the orbit, which in turn produces exophthalmos.

Osteomas arising in the paranasal sinuses, especially in the ethmoid sinuses, encroach upon the orbit and cause the so-called "ethmo-orbital osteomas." These are true tumors and not hyperostoses. As an important cause of exophthalmos they will be described at length farther on.

7. *Deformity of the optic canal.* In the series of cases here discussed enlargement of the optic canal was found in seven instances of glioma of the optic nerve or chiasm, in five cases of neurofibromatosis, in two of meningioma, in one of retinoblastoma, and in one of extrabulbar sarcoma of the choroid. Erosion of the optic canal was seen in cases of aneurysm of the ophthalmic or internal carotid arteries, arteriovenous aneurysm, pituitary adenoma, retention cyst of the sphenoid sinus, and epithelioma of the sphenoid sinus. Circular enlargement of the canal was encountered in all the cases of glioma of the optic nerve, in one case of meningioma of the optic nerve, and in one case of retinoblastoma. The canals were irregularly enlarged in several cases of neurofibromatosis. In one patient (case 4) with meningioma of the optic nerve the canal was quite irregularly enlarged and was the seat of hyperostosis. In a number of cases of meningioma of the medial third of the sphenoid ridge the optic canal was markedly involved by thickened bone. In the instances of aneurysm the inferior and outer portion of the canal was eroded. In the patient with sphenoid-sinus disease the medial half was involved. In a number of cases of pituitary adenoma the inferior root of the lesser wing of the sphenoid or the floor of the canal was eroded. In one case of neurofibromatosis the optic canal was entirely absent.

A canal may shrink perceptibly in size in optic atrophy, and it inevitably shrinks after enucleation of the eyeball. The smallest canal of the present series was found in a case of congenital atrophy of the optic nerve. In view of its unusual interest, this case is described here. It should be pointed out that the stenosis of the canal was probably the result rather than the cause of the atrophy.

CASE 1. CONGENITAL OPTIC ATROPHY ASSOCIATED WITH STENOSIS OF THE OPTIC CANAL. The patient, a girl, aged 17 years, had had poor vision of the left eye as long as she could remember, and the eye had turned outward for at least 10 years. She had had no serious illnesses nor injuries.

Examination revealed complete primary atrophy of the optic nerve of the left eye, which was otherwise normal. The right eye was normal objectively, with normal field, and vision of 20/20.

Roentgenographic examination was entirely negative, save for the left optic canal, which was described as follows: "The left optic canal is remarkably constricted, oval in contour, and measures 3 by 4 mm. The bone of the walls is normal and the adjacent sinuses are clear. The right optic canal is slightly oval in contour, measures 4 by 5 mm. in diameter, and is entirely normal in appearance (fig. 5).

"Impression: Congenital stenosis of left optic canal."

8. *Miscellaneous.* The most striking deformities of the orbits were observed in four cases of pulsating exophthalmos due to congenital retrobulbar tumors associated with extensive defects in the

walls. In all these cases there were large openings through the lateral walls and roofs permitting direct communication of the orbit with the intracranial cavity. Neurofibromatosis was responsible for the deformity in two cases, and congenital hemangiomas in two others (case 13). In these cases the pulsation of the eyeball was due to direct transmission of intracranial pulsations to the contents of the orbit.

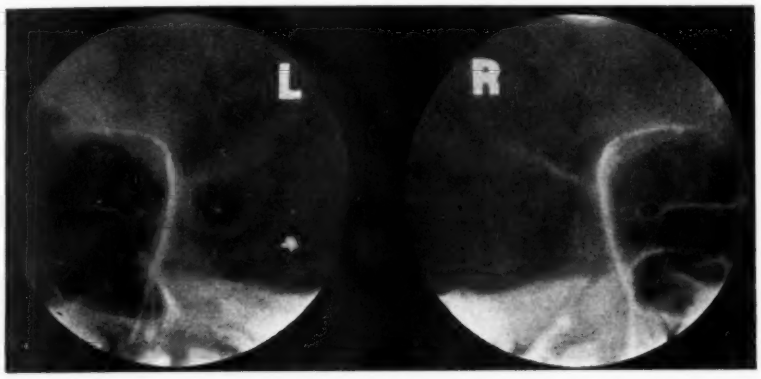

Fig. 5 (Pfeiffer). Case 1. Congenital optic atrophy associated with stenosis of the optic canal. Roentgenograms show the minutely contracted left and normal right optic canal. In order to exclude the possibility that the small size of the canal, as shown in the film, was due to faulty technique, the canal was projected at many different angles, with subsequent further contraction of the lumen.

Roentgenography of Exophthalmos

An appreciation of the numerous and diverse causes of exophthalmos is essential to the diagnosis of primary tumors of the orbit; in every case of suspected tumor a host of other conditions must be excluded. For this reason exophthalmos and the diagnosis of tumors of the orbit will always be a leading clinical problem to the ophthalmologist.[45] The most important modality at his command in this connection is the roentgen ray, and it is the purpose of this study to consider exophthalmos from the standpoint of roentgenography in an attempt to answer the following questions:

1. What percentage of patients with exophthalmos show positive roentgenographic findings?
2. In what percentage of patients with positive findings are the findings indicative or diagnostic? What are the findings?
3. If the findings are not diagnostic, in what percentage of patients are they suggestive when considered in the light of all the clinical and laboratory evidence, and what are these findings?
4. Of what help is the roentgen ray in the study of tumors of the orbit?

Roentgenographic findings may be diagnostic, suggestive, or merely of negative value. As a laboratory procedure, however, in all cases they should be regarded as a part of the case study, and be considered in the light of the history, the clinical manifestations, and other evidence of abnormality. As applied to the orbit, this consideration presupposes a knowledge of the effect of various conditions and processes on bone. In the past, it seems, most of the knowledge of these effects was gained, if at all, at operation,

TABLE 1

ETIOLOGY AND FREQUENCY IN 200 SUCCESSIVE CASES OF EXOPHTHALMOS.

Causes of Exophthalmos	Number of Cases	Positive Roentgenographic Findings	Indicative Roentgenographic Findings	Suggestive Roentgenographic Findings
1. Retention cyst arising in paranasal sinus (mucocele)	18	18	16	1
2. Pseudo tumor or granuloma of the orbit	16	2	0	1
3. Meningioma	14	14	12	2
4. Craniostenosis	14	14	14	0
5. Hyperthyroidism	12	1	0	0
6. Cavernous hemangioma	12	10	0	8
7. Oculomotor paralysis	9	0	0	0
8. Dermoids and epidermoids	8	7	4	4
9. Sarcoma, various types	8	7	0	2
10. Neurofibromatosis	7	7	7	0
11. Deformity or asymmetry of the orbit	7	7	5	2
12. Glioma of the optic nerve or chiasm	6	6	6	0
13. Arteriovenous aneurysm	6	4	3	1
14. Malignancy of paranasal sinuses	5	5	2	2
15. Mixed tumor of the lacrimal gland	5	2	0	2
16. Sacculated aneurysm of the internal carotid artery	4	4	3	1
17. Abscess of orbit	4	2	0	2
18. Ethmo-orbital osteoma	3	3	3	0
19. Paget's disease	3	3	3	0
20. Congenital coloboma cyst of eyeball or retinocele	3	2	0	0
21. Basal-cell epithelioma	2	2	0	2
22. Neuroma	2	2	0	0
23. Myopia	2	1	0	1
24. Gumma	2	1	0	0
25. Xanthomatosis	2	2	2	0
26. Blood cyst of orbit	1	1	0	0
27. Myeloma	1	1	1	0
28. Trichinosis	1	0	0	0
29. Osteitis fibrosa cystica	1	1	1	0
30. Lipiodol in orbit	1	1	1	0
31. Subdural hematoma	1	1	1	0
32. Undiagnosed	20	7	0	3
	200	138	84	34

Explanatory note: The term "exophthalmos" is used to indicate any degree of unilateral proptosis measurable with the Hertle exophthalmometer, and bilateral proptosis, which is clinically apparent. All cases were referred for roentgenography because of prominence of one or both eyes. "Indicative roentgenographic findings" were those considered to be diagnostic or nearly so. "Suggestive roentgenographic findings" were those which, when considered in the light of clinical evidence and other laboratory data, permitted a presumptive diagnosis by the roentgenologist. The value of negative roentgen-ray reports is not considered in this table.

for very little information of the bony orbit came to us by way of the post-mortem table. Now, however, with the aid of the roentgen ray, we are reaching a stage in the development of our knowledge of orbital pathology at which we are able not only to diagnose many causes of exophthalmos but to differentiate, with some degree of accuracy, a few, at least, of the various tumors that occur in the orbit.

A series of 200 consecutive cases has been studied. There were positive roentgenographic findings in 138 of these, and of this number the findings were indicative or diagnostic in 84, or 42 percent, of all cases. In an additional 20 percent the findings considered in the light of all the clinical and other laboratory evidence, suggested the diagnosis. In the following table the 200 cases are listed according to the etiology and in the order of fre-

quency, and there are shown the number of cases in which the findings were indicative or suggestive. Many other conditions known to cause exophthalmos were not encountered in this series, a fact that suggests their rarity.

It will be seen from the table that 131, or two thirds of the cases, were due to one or another of the first 12 conditions listed, and that three of these conditions —that is, pseudotumor, hyperthyroidism, and oculomotor paralyses, which caused 37 or one fifth of the total number of cases—did not show helpful roentgenographic findings. This high percentage of negative findings (18.5 percent), however, is misleading as an index of the value of the ray in the study of proptosis, since oculomotor paralyses and most cases of hyperthyroidism can be differentiated clinically, and our present knowledge of pseudotumor, together with its clinical appearance and history, combined with negative roentgen findings, should in most cases differentiate it from all other conditions.

It may seem remarkable that in 42 percent of all cases the roentgen findings were indicative of the diagnosis. This figure, of course, will vary with the findings of the different laboratories. The number of these cases depends in part upon a knowledge of the causes of exophthalmos, the interest of the roentgenologist in studying the orbits, and the technique employed. In 6 of the first 12 conditions listed (one third of all the cases)—that is, retention cyst, meningioma, craniostenosis, neurofibromatosis, deformity of the orbits, and glioma of the optic nerve or chiasm—the roentgen ray finds its greatest usefulness. Evidence of these conditions on the roentgenogram is usually striking if the proper technique in the production of the films has been employed. In cases of dermoids and hemangiomas, on the other hand, the findings are usually suggestive; orbital sarcomas, however, are nearly always impossible to diagnose.

The greatest cause for alarm in exophthalmos is the possibility that it may be caused by a malignant growth. In the present series there were only 13 cases of primary intraorbital malignant neoplasms —eight sarcomas and five mixed tumors of the lacrimal gland—a total of 6 percent of all cases. In eight cases, the orbit was involved secondarily, five being due to malignancy arising in nasal fossae or sinuses, two arising in basal-cell epithelioma, and one originating in a myeloma. Altogether 10 percent of all the cases of exophthalmos were associated with cancer.

Benign and malignant neoplasms and cysts occurred in 74 or 37 percent of all cases. Of this number, accurate diagnosis was made from positive, roentgenographic findings in 33 or 44 percent, and positive or suggestive findings were observed in 20 more. Because of this high percentage of success some value must also be placed on the negative reports recorded in certain cases.

These figures on the relative frequency of benign and malignant tumors emphasize the need for making a thorough study of every case of exophthalmos, and for securing dependable roentgenography if preoperative diagnoses are to be made and a high percentage of patients saved the disturbance of function which surgery of the orbit so frequently entails.

(Part II will appear in the next issue.)

NOTES, CASES, INSTRUMENTS

OCULAR MYIASIS (OPHTHALMOMYIASIS)

Report of a case

R. D. Harley, Capt. (MC), A.U.S.
Ancon, Canal Zone

The term myiasis includes a number of traumatic conditions of the tissues caused by parasitism by the larvae of certain flies (Diptera). In the order Diptera the Muscoid or Housefly section is of particular importance from the standpoint of animal parasitism. A dozen or more species of several genera have been recorded as causing myiasis in man. Human myiasis is not infrequent in Mexico, Central and South America, and in the tropics in general. The incidence of this fly parasitism is enhanced by the presence of animals, squalor, and shiftlessness on the part of many of the inhabitants. If in addition to these factors one considers the myriads of insects which thrive in warm climates little imagination is necessary to account for the occurrence of such infestations.

Generally speaking, we may consider the habits of flies under two headings: those which are true parasites and those which may be termed as a facultative saprophytic type. The former invade the normal healthy tissue of the host, whereas the latter characteristically lay their eggs amongst the products of organic decomposition whether it be a manure heap or the necrotic tissue of an open wound in man.

Certain oviparous species lay their eggs on the surface of a suitable host. Others deposit their ova in the mucous membranes by means of ovipositors, while still others are viviparous and deposit living larvae which then proceed to burrow into their new homes. The other variable is the behavior of the larvae concerned. Some larval species are known to remain in their nidus and set up little reaction on the part of their host wherein others multiply rapidly and invade the neighboring tissue, often destroying as they go until the center of their former home is a crawling pit with an extremely noxious odor.

However, in the case of Dermatobia hominis, it is known that when this fly is prepared to lay her eggs she manages to attach, by a gluelike excretion, 15 or 20 eggs to the under surface of certain mosquitos or biting flies. The selection of an egg vector by the female Dermatobia seems largely a matter of the most available species. As she can deposit several hundred eggs she probably approaches many different insects. The larvae develop in about a week, and if the mosquito or biting fly attacks man or some animal they escape from the egg case, but otherwise, they will remain in the egg shell until there is opportunity to attack a suitable host.

The larvae of Dermatobia hominis are able to burrow through intact skin and have been observed to make their entrance within one hour after having been deposited on the skin. Here they set up a mild irritative reaction on the part of the host, and if left alone will begin to exit from the skin within 46 to 54 days. At this time they become a pupa and emerge within 22 to 24 days as an adult botfly. In man, the Dermatobia hominis larvae have been seen most commonly under the skin of the legs, forearms, and back. Less commonly have they been noted under the skin of the face or about the eyelids. In some cases, these larvae may simply burrow into the skin of the eyelids or under the conjunctiva, where they may migrate into the tear sac or

down the nasal duct. In each instance, they set up an inflammatory reaction which, as a rule, is poorly tolerated by the host. Instances are on record in which certain other larvae, particularly Hypoderma bovis, ventured intraocularly, where they have been recognized in the anterior chamber, and an iridocyclitis resulted, or in which their further posterior wanderings have resulted in a retinal detachment.

The following brief case report is given to illustrate how the larval form of a botfly masqueraded as a chalazion. An Ecuadorian laborer, 29 years of age, came to the Gorgas Hospital Eye and Ear Clinic on September 23, 1942, complaining of a painful swelling of the right upper lid which he had noticed for the past few weeks. There was no previous history of any similar eye trouble. On examination, the upper lid was seen to be moderately swollen and red, with a lump about the size of a large lima bean in the middle of the lid. The conjunctival surface of the lid was negative except for the presence of the mass. The rest of the eye examination revealed nothing of pathologic interest, and the patient was advised to use hot applications for the inflammatory condition. He returned three days later, at which time the inflammatory condition had largely subsided, but the lump on his eyelid was even more evident than before.

At this time a tiny pinpoint opening on the skin surface of the lid was evident. It was noticed that tiny bubbles were coming from the opening, but unfortunately no significance was attached to this observation at the time. The patient was instructed to continue the hot fomentation and to return in four or five days for an incision and drainage of the mass, since it seemed too large to disappear by resolution. On the next visit a small skin incision was made over the mass and there was easily removed from the wound a white "flask-shaped" mass which gave evidence of life. Inspection of the wound revealed no other foreign bodies. An entomologist identified the specimen, measuring 15 mm. in length, as the larva of the human botfly, Dermatobia hominis, which belongs to the family. Cuterebridae under the large Muscoid group.

One other similar observation was made by Lagleyze[1] of Buenos Aires on the upper lid and cheek of a sailor whose ship traveled between Buenos Aires and Paraguay. Incisions made into the furunclelike mass of the upper lid resulted in the removal of larvae 16 mm. long, which he classified as those of Dermatobia cyanoventris.

It has been suggested that removal of these larvae can be accomplished by cocainizing and then stretching the tiny skin aperture with forceps while making proper counter pressure, since the narrow end of the larva is toward the skin surface from which breathing and the extrusion of black feces is accomplished. Others have suggested the use of bichloride-of-mercury soaks, which kill the larva. In any event, either anesthetized or killed, the animal is rendered much more extractable since the numerous tiny bristles over its body are relaxed, thus permitting it to be removed from its nidus with ease.

The ophthalmologist practicing in the tropics may easily recognize a similar myiasis infection if in addition to an inflammatory mass about the eye a small discharging aperture can be found. Removal of the parasite results in prompt recovery.

Gorgas Hospital.

Reference

[1] Lagleyze, P. Cited by Elliot in "Tropical ophthalmology." Oxford Medical Publications, 1920, p. 195.

BEE STING OF THE CORNEA

L. Pellman Glover, M.D.
Altoona, Pennsylvania

The following case is reported because no similar instance could be found in the literature.

C. J., a boy aged 13 years, was sent to the eye dispensary by his family physician on June 27, 1942, with the statement that a week previously the boy had been playing in the grass, when a honey bee stung his right eye. The parents are of poor mentality and did nothing about the condition for a week, when the boy's sight became poor.

On examination, vision was limited to 6/60 in the right eye. Slight soreness but no pain was present. The lids showed no edema and no bee sting could be detected. Slight ciliary injection such as is observed in a low-grade iritis was evident. Just at the limbus, at the 3-o'clock position, was a small black area which on close examination proved to be the end of the bee sting. This had entered the limbus and been forced through and across the interstitial tissue of the cornea for about 5 mm., where the tip could be seen near the center of the cornea. Around this was a slight haze, such as is seen when any foreign body has lodged in the cornea for some time. No gross K.P.'s were present. The iris was not edematous, but reacted poorly, due to a partial posterior synechia. A thin sheath of exudate overlay the lens.

Local anesthesia was used in the eye, and by grasping the tip with a small iris forceps, the sting was easily withdrawn. It measured 4.5 mm. and was quite stiff, like a thorn.

The eye was so quiet that the boy was sent home to use atropine sulphate and hot compresses, with orders to report in two days. Three days later he came back with the eye violently inflamed and presenting an extremely severe serous iritis. The father admitted that he was a medical authority and did not think any treatment was necessary, so no atropine had been used. The boy was hospitalized. Under atropine, neosynephrin, heat, and typhoid therapy the eye rapidly cleared. On July 16, 1942, the patient was discharged. The track of the sting could no longer be seen, but in the interstitial tissue, where the tip had lodged, there was a small triangular-shaped opacity. The iris could be fully dilated, and no exudate remained aside from a few fine corneal precipitates. Vision was 6/6−. The severe iritis was probably caused by the release of bee venom when the sting was removed.

1200 Fourteenth Avenue.

SOCIETY PROCEEDINGS

EDITED BY DR. RALPH H. MILLER

WASHINGTON, D.C., OPHTHALMOLOGICAL SOCIETY

February 2, 1942

DR. E. LEONARD GOODMAN, *presiding*

OPHTHALMIC SURGICAL ANATOMY

DR. A. B. REESE (by invitation) presented a paper on this subject. He gave the average measurements for locating the ciliary zone, the ora serrata, and the vortex veins. He also discussed the different types of limbus, the horizontal and the vertical, in which it is overlapped by the conjunctiva, with the suggestion that the limbus be studied before a trephining is done. He cautioned that Descemet's membrane may be detached if the trephine is dull, but pointed out that a separation of Descemet's membrane which occurs in cyclodialysis is usually not serious. This membrane is elastic, and since elastic tissue tends to disappear with old age, there may be changes in later years. Wrinkling of Descemet's membrane occurs (1) when intraocular pressure has been high and has been reduced by treatment or operation, (2) when corneal edema has been present and subsides, and (3) following operative manipulations with buckling of the cornea.

Dr. Reese said the sclera also loses elasticity in old age and there may be calcium deposits. Such deposits, if in the form of plaques, may interfere with a cataract section. A loss of volume in the eye in the young is made up by elasticity of the sclera. In older people, it is made up by (1) collapse of the cornea, (2) sucking of air into the anterior chamber, (3) detachment of the retina, and (4) collapse of the sclera.

In a cyclodialysis operation, the anterior emissary artery is usually injured. For that reason some operators have the patient placed in a sitting position, so that if there is bleeding into the anterior chamber it will go to the lower part and away from the site of operation. Such bleeding in aphakic eyes may cause harm by infiltrating into the vitreous. These arteries may be dilated in glaucoma. They are also dilated in the sector overlying a tumor of the ciliary body. A long ciliary nerve may make a loop just beneath the conjunctiva and resemble a small tumor. The most posterior of the zonular fibers supporting the lens are attached to the ora serrata. This explains retinal separations following traumatic cataract and the needling of tough membranes.

The iris pigment seen at the pupillary margin tends to disappear with age. In diabetes it may become edematous. In older people, just behind the sphincter of the iris, fibrous tissue interposes itself. This tends to contract and is responsible for the miosis seen in the aged, Dr. Reese stated. The iris is thinnest and most easily torn at its attachment to the ciliary body. Some of the ciliary processes may be on the posterior surface of the iris.

The ciliary body is largest in hyperopia and smallest in myopia. The hypertrophy of the ciliary body in hyperopic patients may help to account for embarrassment of the angle and the resulting increased intraocular pressure.

ANGIOMATOSIS OF THE RETINA

DR. G. VICTOR SIMPSON presented a patient with angiomatosis of the retina and reported the history of the case.

ANGIOID STREAKS WITH BILATERAL RETINAL LESIONS

DR. STERLING BOCKOVEN presented a case report on this subject.

PARENCHYMATOUS KERATITIS FOLLOWING MUMPS

DR. EVERETT CALDEMEYER reported on a case of this nature.

HYPERPHORIA

DR. ERNEST SHEPPARD showed colored motion pictures illustrating the hyperphorias.

Sterling Bockoven,
Secretary.

COLLEGE OF PHYSICIANS OF PHILADELPHIA

SECTION ON OPHTHALMOLOGY

February 19, 1942

ALFRED COWAN, M.D., *chairman*

FURTHER STUDIES OF THE PENETRATION OF SULFATHIAZOLE INTO THE EYE

DR. H. G. SCHEIE reported on experiments which showed that microcrystalline sulfathiazole penetrated into the aqueous humor of normal eyes to about the same percentage of the blood level as does regular sulfathiazole, about 24 percent. In other groups of animals with infected eyes, all work being on cats, sulfathiazole was seen to enter the aqueous in much greater amounts. In cases of severe vitreous abscesses the aqueous level was 91 percent that of the blood. Vasodilators also increased the penetration of sulfathiazole. It was concluded that the use of sulfathiazole, at least in severe intraocular infections, was justified.

Discussion. Dr. F. H. Adler remarked that the results of these experiments were clear and convincing. They had a value which was beyond their immediate results, because they pointed out factors that must be taken into account when evaluating the effect of drugs in the eyes. They showed an effect that one cannot always deduce; namely, the action of a drug in a diseased condition as compared with its effect in a normal eye. As Dr. Scheie pointed out, in ocular infections the blood-aqueous barrier is altered and is much more permeable than in the normal eye. As a result of this, certain drugs which fail to pass through the normal barrier are found in the inflamed eye.

As to the microcrystalline form of sulfa drugs, Dr. Scheie said, last year Dr. Souders, in their department, was interested in obtaining some of the sulfa drugs which could be injected by hypodermic needle. The ordinary sulfa crystals are too large to go through the bore of a hypodermic needle. The biochemists in the Johnson Foundation succeeded in obtaining the sulfa drugs in microcrystalline form. The importance of this was immediately realized by other departments in the hospital and, as a result, extensive research was begun under a grant from the Smith, Kline, and French Company, under the direction of Dr. Joseph Stokes, Professor of Pediatrics. The microcrystalline form of these drugs was now being investigated by various members of their department.

As a result of these experiments of Dr. Scheie and Dr. Leopold, they know that the ordinary form of these drugs may be used by injecting them into the blood stream. If it was advisable to inject the drug directly into the vitreous or aqueous, the microcrystalline form may be used.

TEMPORARY ABDUCENS PARALYSIS NOT ASSOCIATED WITH OTHER GENERAL OR NEUROLOGIC ABNORMALITIES

DR. W. I. LILLIE reported eight cases

of temporary abducens paralysis in the absence of evidence of associated general or neurologic pathology. These cases were the result, apparently of undue exposure while driving or riding in an automobile. Seven cases were in men who developed a paralysis of the left abducens nerve while driving with the car window partially or completely opened. The one woman was a front-seat passenger and developed a right abducens paralysis. A general and neurologic examination, including spinal fluid and roentgenograms, was completed in all eight cases, but with negative results except for the abducens paralysis. The ages ranged from 42 to 68 years. The time interval between exposure to the appearance of the diplopia varied from 2 to 10 days. The duration of the diplopia varied from three weeks to six months.

The end-result in all eight cases was a complete restoration of function together with disappearance of the diplopia. The therapy in these cases was purely empirical.

Discussion. Dr. G. G. Gibson observed that Dr. Lillie had just presented a new cause for a well-known clinical entity, abducens palsy. The new cause which he ascribed to this condition was exposure to a draft encountered by the patient while riding in an automobile with the window open.

Dr. Lillie's paper was of special interest to him because it was his privilege to see two of those patients, and on examining them and listening to their story, one was very readily convinced of the accuracy and correctness of Dr. Lillie's conclusions and the diagnosis which he had made. Necessarily, in this group of cases, one had to make the diagnosis by exclusion, and those who required 100 percent proof of the exact mechanism of these cases would find something wanting in Dr. Lillie's interpretation, because there was no way in which the correctness of this assumption could be proved. However, Dr. Lillie had, by exclusion, arrived at the best possible explanation of this group of conditions, and in view of this explanation it was possible to concur in the conclusions which he had reached.

It was interesting that he compared this inflammatory lesion of the abducens nerve to Bell's palsy, an inflammatory condition of the facial nerve. It was extremely difficult to exclude such rare conditions as a possible hemorrhage into the nerve from exposure. Dr. Lillie had not expressly mentioned that he had excluded multiple sclerosis as a cause of this condition, but he was sure that Dr. Lillie had done so, because he had taught him, many times, the importance of excluding multiple sclerosis in similar cases. He wished he would say that these cases were not in the proper age group, or had not the proper personality for multiple sclerosis. That fact, combined with the negative spinal fluid, would rule out the possibility of multiple sclerosis.

It was rather difficult to understand how the sixth nerve, which is so well protected both in the depths of the cranium and in the depths of the orbit, as compared to the relatively exposed position of the facial nerve, could be affected by exposure. In view of that, he would like to ask Dr. Lillie what his conception of the actual mechanisms in these cases was.

One would like to know if he considered this purely exposure *per se,* or whether he conceived of it as a decrease in local resistance of the nerve, permitting a secondary inflammatory lesion to occur. One wondered if it would be possible for this condition to occur bilaterally if there were proper conditions of exposure to both abducens nerves.

It was of interest that Dr. Lillie's ex-

perience in this exposure type of neuritis started in 1934, shortly after he left Minnesota and came to Philadelphia. He wondered if this was purely a coincidence or if there was some difference in the climatic conditions, or the resistance of the individuals here, as compared to that in Minnesota. He did not say this facetiously, because he knew there was a marked difference in the types of cases encountered in the practice of ophthalmology in Minnesota and in Pennsylvania. An example of that was an instance which Dr. Lillie mentioned in his lectures that afternoon to the senior students, at which time he compared the relative incidence of pterygium, here, and in Minnesota. It was their experience that there was a high incidence of pterygium there, due to the climatic condition. In Philadelphia, that had not been the case.

He had had a case recently which, if not exactly similar to those in the group which Dr. Lillie had presented, was comparable to them, at least, and which required a differential diagnosis from this syndrome: A man, 60 years of age, had a sudden onset of diplopia and presented himself with the characteristic picture of a paralytic sixth-nerve palsy. On questioning him closely, it was learned that his occupation was that of a cashier in a restaurant, and he was stationed close by a revolving door, and had been exposed, three days before the onset of his palsy, to a very severe draft during a recent period of cold weather. However, in this case, it was learned on closer examination that the patient had previously had a sixth-nerve palsy, and this particular condition was merely an exaggeration of a condition which previously existed, so it probably was not fair to include it in this group of cases, although it might well present an identical instance. The diplopia, however, cleared up without any treatment in three weeks, but it did not have the complete work-up which Dr. Lillie had given his patients.

This presentation had been very interesting to him and he wished to thank Dr. Lillie for calling their attention to this interesting cause of abducens palsy.

Dr. M. H. Langdon commented that he was interested in two things about Dr. Lillie's paper. One, the temporary phase of the condition. He would like to have a definition of what "temporary" was. He remembered one case, of a man who came to Dr. Mitchell with a long-standing paralysis of the right external rectus muscle. He could find no cause for it in the patient's history or on physical examination, and Dr. Mitchell could not in his general neurologic examination. They had asked Dr. de Schweinitz to see him, and Dr. de Schweinitz was evidently as puzzled as they were but did not say so in so many words. He gave them all the possibilities and, among others, suggested that it might be an example of one of the transient palsies of Mauthner. So what did they mean by temporary and transient?

He was very much interested in Dr. Lillie's paper and remembered four cases of palsies that he had seen: two of a unilateral external rectus, one of a bilateral external rectus, and one of a superior oblique; all with absolutely unexplained etiology; all with absolutely no other neurologic signs, and all making a complete recovery in a more or less brief space of time.

One of these patients was a young woman, aged 25 years, with a history of double vision on looking to the right for the past several days. She could not remember just when it began—within three days to a week ago. Vision was 5/4—near point suitable for age—the pupil of the left eye was slightly larger than that of the right, but reacted well

to light and accommodation. Ocular rotation was full, except the outer rotation in the right eye, and there was a diplopia typical of a right external paresis; there were no fundus changes. The Wassermann test was negative; spinal fluid negative; knee jerks were normal. Dr. Francis Sinkler made a complete neurologic examination. When he himself first saw her on September 19th, the patient had an esophoria, measured on the Maddox rod, of 40 degrees. By April 22d of the following year she was perfectly normal—three degrees of esophoria—rotations were full, and there was no diplopia.

The second case. A man, 37 years of age, had awakened, seeing double, three weeks before consulting Dr. Gibson, who found normal vision in each eye; no pupillary changes; no neurologic signs, except an absence of knee jerks, but there was nothing of a neurologic nature. The patient was also examined by a competent neurologist. The Wassermann test was negative; spinal fluid negative; and there was nothing to account for the condition. He had 3 degrees of esophoria for distance, but a left hyperphoria of 10 degrees and a diplopia typical of left superior oblique involvement. This was in June, 1938. By January, 1939, the diplopia had entirely disappeared and the muscle-balance test showed orthophoria at 5 meters.

The third case. A woman, 56 years of age, whom he had seen periodically for refraction during the preceding 10 years, reported with a history of double vision and some nausea. Examination showed her corrected vision was 5/5 in each eye; near point suitable for age, with a reading glass. Muscle balance, measured on the Maddox rod, showed 20 degrees of esotropia. Previous to this there had never been more than one or two degrees. Diplopia over the entire field suggested right external rectus paresis. The neurologist found no signs of central-nervous-system disease. The Wassermann test was negative. The patient would not allow a spinal-fluid test. She also gave a very interesting history that 30 years before she had had a similar attack in which she had been seen by a Dr. S. D. Risley, who wished to operate on her. The condition gradually improved and by June, 1932 (February 27, 1932, was her first visit), she was entirely normal and since then has had no other attacks.

The fourth case was one of bilateral external rectus palsy and also a loss of inward rotation of each eye with no loss of upward or downward rotation. This, he thought, was a case of encephalitis in the neighborhood of the aqueduct. The patient had normal vision. On her first visit there was absolutely no diplopia, and her muscle balance was one degree of esophoria, vertical bar meridian. The following day, however, there was definite diplopia on looking to the right, and within a week there was complete loss of outward rotation in each eye and very definite diminution of inward rotation. Upward and downward rotations were normal and never disturbed. The patient would not see a neurologist. Her physician examined her very carefully and he had had a certain amount of neurologic experience. The blood Wassermann test was negative; the spinal fluid was not tested. Her treatment began very promptly, consisting of nothing but rest and iodides. In two months from the time of the onset she made a complete return to normal, with no diplopia. Ocular rotations were full, 1 degree of exophoria, at 5 meters, and 4 degrees at reading distance. There had been no recurrence of anything of the kind. He thought she must have had an attack of encephalitis.

He was glad that he had brought these cases. He thought they ought to realize

that all cases of external rectus palsy do not come from riding in motorcars.

Dr. W. E. Fry's question was in regard to the time of recovery. As he understood it, most of the patients recovered rather early, within six weeks, but in one or more instances recovery was not complete for a period of six months. He wondered if Dr. Lillie recalled how soon recovery began to appear in that case, or in the cases that did not recover for the six-month period.

Dr. S. Brav stated that Dr. Langdon had reported the Wassermann test to be negative, but they had not heard anything about the blood-sugar test. In his experience, many of the external-rectus-palsy cases he had seen were due to blood-sugar changes.

Dr. M. H. Langdon answered that he had replied to that question as far as his cases were concerned. The blood chemistry was ascertained and it was negative in all of them, as far as the blood sugar was concerned, and the ordinary routine blood-urea clearance, and so on.

Dr. M. Buchanan asked Dr. Lillie about the humidity in Minnesota as compared with that in Philadelphia.

Dr. W. I. Lillie said he was pleased that his presentation had aroused so much discussion. The cases reported by Dr. Langdon did not fall into the group that he had reported because apparently no direct causal factor could be ascertained from his history. Just what the actual cause for the sixth-nerve paralysis in the cases he had presented was, he did not know, although it was safe to postulate that the basic pathology must be either an inflammatory or a vascular condition.

In answer to Dr. Gibson's numerous questions, he also admitted that many causes are known to produce a sixth-nerve paralysis, but the general or neurologic examination usually reveals the cause, so that this type of case could be ruled out inasmuch as all revealed negative findings both from the general and neurologic standpoint.

In answer to Dr. Buchanan's question as to the relative difference in the humidity between Minnesota and Pennsylvania, he was quite sure that the weather in Philadelphia was much more humid, but he did not believe the humidity was a factor in the sixth-nerve paralysis.

A few years ago Dr. Yaskin of Philadelphia presented a paper on paralysis of ocular rotation in which a group with sixth-nerve paralysis was mentioned, but in his group there was no direct relationship to exposure, although he did mention the term "exposure" as a possible cause. He believed that Dr. Yaskin's cases could be closely related to his, although the direct relationship of the paralysis following riding in an automobile was not elicited.

In answer to Dr. Fry's question of duration of the paralysis: Before improvement was obtained in his series, the longest time interval was between four and six months.

Lagophthalmos cicatricial

Dr. E. B. Spaeth stated that from a surgical standpoint, lagophthalmos could be subdivided into (a) the form resulting from the loss of soft tissue as, for instance, following malignancy of the upper lid and posttraumatic conditions; (b) the lagophthalmos of orbicularis paralysis; (c) cicatricial lagophthalmos; and (d) lagophthalmos which was an accompaniment of high degree of exophthalmos. The reason for this surgical subdivision is based upon the necessity for varied procedures for each of the conditions.

It had been his privilege to have shown films before the Society illustrating the

second and third groups of this classification; the fourth is still in preparation.

The film which was to be shown this time illustrated the first group of the four mentioned. It consisted of two cases. In the first, the soft-tissue loss was due to traumatism. The upper lid had had several through-and-through lacerations, and, because of this, in addition to the high degree of ectropion present, a free skin graft could not be used; a pedicle flap was thought necessary.

In the second of the two cases the lagophthalmos was apparently associated with recovery from a malignancy of the forehead and the temporal region. There had been no malignancy in the lid itself; the contracture was due to the radium treatment. In this way, the film should ilustrate the two basic procedures on rather typical cases.

Warren S. Reese,
Secretary.

CHICAGO OPHTHALMOLOGICAL SOCIETY

February 16, 1942

DR. SANFORD GIFFORD, *presiding*

CLINICAL MEETING

(Presented by the Department of Ophthalmology, Loyola University)

VERIFIED OPTICO-CHIASMATIC ARACHNOIDITIS

DR. CARL F. SCHAUB said that J. C., a man, aged 30 years, had been presented before the Society in March, 1939, as a diagnostic problem (Amer. Jour. Ophth., 1940, July.) He had been under observation since that time, and the history of the case was reviewed. In December, 1939, papilledema was increased in each eye, fields were more restricted, and vision in the left eye diminished from 20/12 to 20/50. A definite pallor was noted in the elevated disc of the left eye. Neurologic and X-ray studies gave negative findings.

Because of the increasing pathology and the probability of occurrence of field defects and optic atrophy in the right eye, exploration of the chiasm was advised. The typical picture of plastic adhesive optico-chiasmatic arachnoiditis was found, with much thickening and many constricting bands, especially of the optic nerve of the left eye. The basal cistern was greatly dilated. Following operation there was almost immediate recession of the bilateral papilledema. The margins of each disc were distinct, with no evidence of swelling; the disc of the right eye was normal; that of the left, showed secondary partial atrophy. By September the central vision had improved to 20/24 with correction, and the field defect had receded slightly. At last examination, February, 1942, the vision, R.E., was 20/12 with correction; L.E., 20/20+4 with correction. The whiteness of the left disc was noticeably less. The peripheral field defect of the left eye remained.

Inasmuch as there had been temporary improvement in February, 1939, after sphenoidal opening, with demonstrable sphenoidal purulent infection, it was felt that the sphenoiditis may have been the cause of the basal cistern inflammatory process.

BILATERAL MACULAR CYSTIC DEGENERATION (APPARENTLY ARRESTED)

DR. CARL F. SCHAUB presented the case of F. J., a woman aged 43 years, who had been under observation for more than 10 years. She was presented before this Society in 1939, with the named diagnosis. When refraction was done in 1931, the vision in each eye was corrected

to 20/15. In 1936, vision had dropped to R.E., 20/50+2; L.E., 20/30 with correction. In each eye a central, well-circumscribed, deep-red circlet, one-fourth disc diameter in size, in the exact center of the macula, was noted. A small pin-head-sized, slate-gray, irregular dot was seen in the center of the area. Relative central scotomata corresponded to the area involved.

General physical and laboratory tests were negative, except for a definite empyema of the left antrum, upon which a Caldwell-Luc operation was performed. Three years later, when first presented before this group, the lesions had not changed ophthalmoscopically, and the corrected vision was R.E., 20/40+2; L.E., 20/30+3.

At this time, six years after the diagnosis was made, the deep-red area was not so well circumscribed as when first seen. Vision had remained stationary. The patient has been kept under observation.

A case of basal-cell carcinoma of the puncta

Dr. J. R. Fitzgerald presented such a case.

Acne rosacea keratitis

Dr. E. A. Roling demonstrated the case of J. K., a woman, aged 46 years, who gave a history of myopia since the age of 15 years. She was treated for a corneal ulcer of the left eye three years ago; had had acne rosacea for the past 10 years. The eyes had been inflamed intermittently, with photophobia, for the past eight years. The vision in the right eye was 20/100, corrected to 20/50; left eye 5/200, corrected to 20/40. The right eye was relatively quiet at this time but showed old opacities of previous corneal involvement. In the left eye acne lesions were seen, with blood vessels leading to the areas recently ulcerated. The areas did not stain with fluorescein, but the epithelium was rough and irregular. The patient had been given riboflavin as well as local treatment.

Rupture of iris sphincter: dislocated lens: zonular lamellar separation: traumatic edema of macula with possible choroidal tear

Dr. John F. Wixted presented the case of E. K., a 14-year-old white boy, who was seen in January, 1942, two days following a fall in which his right eye was struck with a stick. The vision in the right eye was reduced to 5/200. A tremulous iris was seen, with a mass of pigment 2 by 5 mm. in size on the iris at the 5-o'clock position, and an apparently shallow laceration of the sclera, 8 mm. below the limbus, from the 5- to the 6-o'clock position, with a slight amount of bulbar and palpebral conjunctival injection. Intraocular tension was soft to palpation.

On slitlamp examination the cornea was clear, with good luster. The anterior chamber was deep and contained vitreous. A transparent mass 3 by 5 mm. was seen, bulging into the pupillary area from the rim of the iris, in addition to the findings noted above. Except for horizontal corrugation on the anterior surface, the lens appeared normal. Fundus details could not be discerned.

With bed rest and sulfathiazole and typhoid vaccine therapy, the media cleared and revealed a normal disc. The macular region appeared to be edematous. At the lower border of the foveal reflex there was a broad crescent-shaped yellowish-white line one-fifth disc diameter in length.

The gonioscopic examination showed a marked increase in pigment deposit throughout the trabecular zone over the lower two thirds. The iris was depressed backward, and was tremulous. The cham-

ber was deep. A trabecular pigment ring was present. Pigment epithelium from the pupillary border of the iris was torn off and rolled up on the iris.

At this time the eye was practically quiet. Vision was 20/200. The central field is constricted to 15 degrees, with no scotoma.

SCIENTIFIC PROGRAM

OCULAR DOMINANCE AND MARKSMANSHIP

DR. JAMES LEBENSOHN presented a paper on this subject.

BROTHER AND SISTER WITH JUVENILE MACULAR EXUDATIVE RETINITIS (JUNIUS)

DRS. PALMER GOOD and ROY O. RISER presented a paper on this subject.

Discussion. Dr. Robert Von der Heydt pointed out that the Kuhnt-Junius monograph on disciform macular degeneration of 1926 referred to senile changes of an atheromatous and hemorrhagic character. These should not be confused with the juvenile macular exudative retinitis which Junius described in Amsterdam (1929). In this retinopathy there is no similarity with Coats's exudative retinitis externa, the von Hippel retinitis, or the types covered in the Kuhnt-Junius Atlas. The juvenile exudative type follows a different course, and there is recovery—the latter alone gives to it a different etiology. Calling it a juvenile form of Kuhnt-Junius disease is erroneous and leads to confusion in the literature.

Dr. Palmer Good, in closing, said that the classification of exudative retinitis is at the present time uncertain, and the condition described may be a benign variation of Coats's disease. It occurs in the same place and in the same age group; the chief differentiation being that in juvenile exudative macular retinitis vision is recovered whereas in Coats's disease it is not.

MACULAR DISEASE

DR. ROY O. RISER presented 89 kodachrome fundus photographs of congenital and acquired lesions of the macular area.

Robert Von der Heydt.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

March 10, 1942

DR. W. LIKELY SIMPSON, *presiding*

UNEXPLAINED REDUCTION OF ACCOMMODATION

DR. JAMES B. STANFORD reported two cases of this condition occurring in young persons.

Case 1. Mrs. J. T. E., aged 31 years, was seen on November 19, 1941. She reported that her near vision had been poor since having a Caesarian section in 1939. She was employed and wanted glasses so that she could do office work.

Anterior segments appeared normal, and the fundi were negative. Her vision was 20/20 in each eye, and Jaeger 10 in the right eye and Jaeger 12 in the left eye. Under cycloplegia she accepted a −0.25D. cyl. ax. 180° in each eye. Neurologic examination, including tests of both blood and spinal fluid, was negative.

She was given a +2.00D. sph. ⊂⊃ −0.25D. cyl. ax. 180° in each eye for near. With this correction the patient has been able to continue office work.

Case 2. Mr. D. R. B., aged 28 years, was seen on December 16, 1941, complaining that it was necessary for him to hold reading matter quite a distance away from his eyes. The condition had existed for three or four months. His vision was 20/20 in each eye, and Jaeger 6 in the right eye and Jaeger 12 in the left eye. Anterior segments were normal and the fundi were negative. Under cycloplegia

he accepted O.D. +0.25D. sph.; O.S. −0.25D. sph. ⌯ −0.25D. cyl. ax. 180°. General physical and neurologic examinations were negative, as were his spinal fluid and blood.

He was given: O.D. +1.50D. sph.; O.S. +1.50D. sph. ⌯ −0.25D. cyl. ax. 180° for reading. This has enabled him to continue his duties as a mechanic.

Duke-Elder's textbook has much to say about accommodation, but nothing pertinent to these cases.

Acute glaucoma

Dr. Ralph O. Rychener presented a case of bilateral acute glaucoma in a 73-year-old woman who had just been admitted to the hospital. Her general blood pressure associated with a nitrogen retention had been quite elevated for many years. Two weeks previously some visual disturbance of the left eye was noted, followed within a week by severe pain, at which time she consulted her home oculist, Dr. A. W. Cox of Helena, Arkansas, who prescribed miotics. Two days previously the right eye suffered a similar attack. Similar treatment was prescribed, and the patient was sent to the hospital for surgery. However, the medical treatment resulted in prompt alleviation of the increased tension. Upon admission, the pupils were miotic despite deep scleral injection and small hyperopic eyes, and the tension was 11 mm. Hg (Schiötz) in each eye. Further medical treatment was contemplated until the inflammatory reaction had subsided, when it was expected that bilateral surgical measures would be undertaken.

Ossification of choroid

Dr. W. B. Blaisdell (by invitation) reported the case of a white woman, aged 45 years, who at the age of 10 years had been blinded in one eye by being struck with a nail. The cornea was completely opaque, but there was no scar to indicate the site of the previous injury. The eye was not inflamed and the tension was normal. There was no perception of light. Evisceration was performed, and the whole uveal tract was found to be ossified. The iris and ciliary body were removed first and then the choroid, each as complete bony casts. Sections and microscopic study had not been made. The specimens were exhibited before the Society.

Comment. Following prolonged inflammation of the choroid, hyaline degeneration sometimes takes place which may be followed by ossification. Usually 10 or 12 years are required after inflammation for bone to make its appearance, but it may appear earlier. Bone in the eye is never derived from cartilage, but is always periosteal in type, with the typical structure of long bone.

Cataract extraction on a congenital deaf-mute with the use of fixation sutures

Dr. Phil Lewis reported the case of C. A., a man, aged 55 years, who was first seen in 1938. He was a congenital deaf-mute. His occupation was candling eggs for a poultry house. Due to poor vision he had been unable to work for many months, and recently had been scarcely able to communicate with his friends because he could not read their signs. Cataract extraction, performed on the right eye by another oculist a few months previously, had ended disastrously, with a blind eye. His wife, who was a very intelligent deaf-mute, had been told that the loss of this eye had been due to lack of coöperation during the operation. They were, therefore, very apprehensive about undertaking any surgery on the left eye. However, as he was totally disabled, with vision of only 10/200, operation was advised.

On September 2, 1938, the operation

was performed. A preliminary sedative of phenobarbital was given. Complete paralysis of the lids was secured by a thorough injection of 1-percent procaine by the Van Lint method. The possibility of squeezing was thus eliminated. The routine retrobulbar injection of novocaine was made to insure complete anesthesia. A heavy silk suture (#4 Deknatel) was put through the superior rectus muscle near its insertion into the sclera. A similar suture was placed in the lateral rectus muscle. These bridle sutures permitted a control of movements of the eyeball which was impossible with fixation forceps alone. The cataract was removed in its capsule, no iridectomy being performed, in order that a normal, functioning pupil might be obtained if possible. Convalescence was uneventful. Refraction about eight weeks after operation resulted in normal vision for both distance and near, 20/20 and Jaeger 1. The patient was enabled to return to his former occupation.

Comment. A bridle suture through the superior rectus muscle has been used by some ophthalmic surgeons for many years to prevent a turning up of the eye by unruly patients. The writer had never before used a similar suture in the lateral rectus, nor had he seen it previously used or described. The procedure was recently reported by Bloch of New York (Archives of Ophthalmology, 1941, v. 25, June, p. 1035). Following this first successful experience, the essayist has found it to be very helpful in a few other patients who were profoundly deaf. In one patient who persisted in turning the eye in towards the nose, a bridle suture was used also in the medial rectus muscle. The use of these sutures was recommended in cataract extractions on very deaf patients.

AMERICAN JOURNAL OF OPHTHALMOLOGY

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Author's proofs should be corrected and returned within forty-eight hours to the *Manuscript Editor, Miss Emma S. Buss, 5428 Delmar Boulevard, Saint Louis, Missouri.* Twenty-five reprints of each article will be supplied to the author without charge. Additional reprints may be obtained from the printer, the George Banta Publishing Company, 450-458 Ahnaip Street, Menasha, Wisconsin, if ordered at the time proofs are returned. But reprints to contain colored plates must be ordered when the article is accepted.

ST. DUNSTAN'S

St. Dunstan's was founded toward the end of the last war by Sir Arthur Pearson with the purpose of establishing a training center for Service-blinded individuals. Its value in the last war is too well known to require discussion, and in the ensuing years, until the outbreak of the present war, its graduates were carefully watched and taken care of as by a fraternal type of organization. There were various local and general reunions held at least annually and sometimes more often. Case-workers followed their cases during all these years, helping in innumerable ways to ease the burden of blindness and to improve the quality of training as much as possible. Therefore when the demands of the present war began to increase the burden on St. Dunstan's, many of its graduates were called back as teachers of the newly blinded unfortunates. A recent inspection of St. Dunstan's reveals the careful thought directed toward the care, comfort, and training of those who have been catastrophically blinded.

The individual is taught typing, Braille, shorthand Braille, which is extremely difficult, and the ordinary occupations of the blind with which we, at home, are familiar; such as, weaving, basket-making, and so forth. The two most highly complicated forms of training being un-

dertaken are those of massage and telephony or switchboard operating.

After a careful study of the individual, every effort is made to determine the type of training most suited to him. A number of these men (and women) were personally interviewed, and it was interesting to observe that their courage and morale began to develop often in as short a space of time as one week after their arrival at St. Dunstan's. There have been a few women patients admitted in this war. These are the sad victims of explosions which destroyed their sight either in munitions factories or as a result of the Blitz. The authorities wisely considered that these were Service-blinded people and gave them the same care as they give the soldier, sailor, or merchant marine.

St. Dunstan's is an institution, supported by private funds, that has a far-and-wide popular appeal due to the natural pity that blindness evokes. During its years of existence it has become known throughout the world, and St. Dunstan's graduates are to be found everywhere. The value of such an organization is at once apparent, since it means that as soon as the individual recovers enough from his injury to begin to think, he immediately considers St. Dunstan's and knows, either through hearsay or personal evidence, what it can do for him. He is, therefore, filled with hope and courage and is generally eager to begin his training to learn to be blind. This is a great psychologic advantage, because instead of reluctantly entering into the very trying period of training—a training that requires great powers of concentration—he is in a responsive frame of mind from the outset.

An institution modeled along the lines of St. Dunstan's is being planned by our Government for our men blinded in war, and it will be gratefully received by all of our American people. Derrick Vail.

MEETING OF THE AMERICAN OPHTHALMOLOGICAL SOCIETY

The seventy-ninth meeting of the American Ophthalmological Society was held on June 10th, 11th, and 12th at the Homestead, Hot Springs, Virginia.

Once arrived everything was satisfactory. But transportation problems were difficult, and several who decided to come only at the last moment were unable to get railway accommodations. Eighty-seven members registered and about 15 guests, a very good attendance considering the national emergency. Very few papers were submitted early, probably because of the uncertainty as to transportation. However, the members must have had good material up their sleeves because the program, though perhaps not scientifically outstanding, was exceedingly interesting and there were a number of better-than-average papers. To select any for special comment may indicate rather the interest of the reporter than the merit of the paper. Often especially worthy contributions are abstruse and require careful study, such as is impossible when first heard, before their true significance is appreciated.

To a teacher the "Ophthalmoscopic classification of hypertensive diseases" by Grady E. Clay and Mason Baird was of unusual interest. It seemed one of the best classifications that has been presented. Dr. Clay recommended that a committee be formed to study the subject and report to the Society a year hence. The committee should confer with ophthalmic pathologists because it is most important that the relationship of the clinical and pathologic pictures should be an important part of any disease classification.

Dr. Raymond L. Pfeiffer presented a most illuminating series of 10 cases of traumatic enophthalmos. Beautiful X rays showed clearly fracture of the floor of

the orbit in all. Though the usual Waters position was used, it seemed evident that unless the focus is exactly right and the observer knows just for what to look the pathology might be missed. But as shown in the pictures, there was not the slightest question of the lesion. It is to be hoped that in a subsequent paper the author will tell us what he did for these patients and how effective it was.

A very ingenious method for the removal of certain types of corneal scars associated with conjunctival shortening, such as may follow burns, was presented by Dr. Ramon Castroviejo. After peeling off three sides of a square of the superficial layers of the cornea, the base of this loosened corneal flap was further dissected from the sclera and the entire flap sutured deep in the shortened fornix. This gave a clear cornea and an adequate fornix. The operation was illustrated with excellent moving pictures.

Dr. Wendell L. Hughes reported six cases in which the function of an overactive superior-oblique muscle was much reduced by undermining the insertion of the trochlea into the periosteum and thereby permitting the trochlea to recede toward the apex of the orbit. This relieved the tension on the muscle, making it less effective, possibly also helping in this by changing the direction of the pull of the muscle, rendering its action less powerful. Good results were achieved in all six cases. The procedure looked simple and well worth a trial.

Dr. Arnold Knapp presented interesting statistics on the relationship of retinal detachment and trauma. Of 400 cases, indirect trauma seemed responsible in only 15, direct injury in 35. Fifty percent of these occurred in myopic eyes. The exact mechanism of the indirect trauma as a factor remains little understood.

The meeting seemed so valuable that it was tentatively decided to hold the next annual meeting unless war conditions seemed worse. The Homestead was again selected.

New officers appointed were: Dr. John Green, president; Dr. S. Judd Beach, vice-president; Dr. Everett Goar as the new Council member to replace Dr. Griscom who would have retired from the Board at this meeting. It was with great sorrow that one week before the meeting the report of Dr. Griscom's sudden death was received. Dr. M. H. Post was elected the new representative to the American Board of Ophthalmology. Dr. Walter Atkinson and Dr. Winfred Fry were chosen to succeed themselves as secretary and treasurer, and editor of the Transactions, respectively.

Lawrence T. Post.

PHOTOGRAPHING CROSS-CYLINDER TESTS

Many persons are fairly well informed regarding the analogy between the photographic camera and the human eye.

The photographic lens, at first simple but now as a rule highly compound, plays the part of the human cornea and crystalline lens. The other media of the eye, especially the vitreous, may be broadly thought of as representing the air space within the bellows or box of the camera. The photographic film of sensitized emulsion, on celluloid or on a glass plate, represents the retina. The camera converges the rays of light, from any object contemplated by the camera, to an accurate focus, adjustment for such focus being usually made by the photographer according to the distance between the camera and the principal objects to be photographed.

The camera frequently brings many objects, over a wide field, into focus at the same moment, because the compound photographic lens has been refined so as to

permit accurate focus over the whole of the individual photographic plate or film. The eye, on the other hand, being dynamic instead of static, achieves a similar purpose by rapid movement throughout the desired field of vision, and by readjusting its mechanism with lightning-like rapidity so as to obtain a composite record which in some mysterious way is stamped upon the brain.

The analogy between the eye and the camera is far from perfect. The camera and the photographic film do not see, but merely produce a material record which must be seen and interpreted by the eye and the brain. Apart from the photographer's occasional attempt at blurred mimicry of the effects produced by modern painting ("soft focus"), photography is usually applied to the production of sharply defined representation, so as to give the most accurate information possible concerning the thing or scene photographed. Herein usually lies the value of photography for educational purposes. It enables us, without viewing the actual object or scene, to study at leisure the form and structure of things, the elements of landscape, or the processes of nature or of human activity.

Photography has been used beneficially in conveying education as to the facts and principles upon which are based the science and art of medicine. Among other fields of knowledge, photography can be used in a somewhat limited degree for teaching the technique of refraction work.

There is no particular difficulty in representing the blurred appearance of the test letters as seen by a myopic or astigmatic eye, or the unequal distinctness of the different lines of an astigmatic dial as the vision of them is modified by the presence of inequality between different meridians of cornea and crystalline lens in their combined action upon the focus of the eye.

When we come to portray the delicate variations between the different steps of testing astigmatism with the cross cylinder, the process is rather more complicated and the results may at times be a trifle misleading. In making a series of photographs for this purpose, in such a way as to imitate the effect of such tests upon the human eye, the photographer-ophthalmologist may occasionally obtain results which hardly fit with his expectations and which are more or less deceptive.

The present writer, in making his own series of photographs as regards the behavior of the cross-cylinder test for either the amount or the axis of astigmatism, found it very necessary to maintain a basic focal length for the artificially astigmatic camera. No matter what secondary changes were made from one step to another, the greatest possible uniformity of technique was essential if the photographic results were to be scientifically comparable. Variations in the focal length of the camera, or in the illumination, or in the time of exposure of the photographic plate, or in the conditions of development of the negative (time, temperature, age of developer) or in the printing time or the development time used for the photographic print or lantern slide, tended to produce results which could not be usefully compared.

In a recent essay (British Journal of Ophthalmology, 1943, volume 27, page 1) Williamson-Noble employs a series of photographs to illustrate "a possible fallacy in the use of the cross cylinder."

To introduce his subject, Williamson-Noble quotes the present writer's statement that the cross-cylinder tests are "usually more likely to be successful if the accommodation is relaxed, and, therefore, if whatever spherical lens is in the trial frame is so strong a plus or so weak a minus as barely to allow the patient to

obtain his full visual acuity" (Transactions Ophthalmological Society of the United Kingdom, 1931, volume 51, page 495).

Williamson-Noble proceeds to assume that the use of the word "barely" in the above sentence implies a recommendation that the vision of the patient be kept fogged throughout the cross-cylinder tests. Perhaps "only just" would have been a better expression than "barely," but it is surely not altogether justifiable to assume that fogging was implied, since "barely" is quite commonly used in the sense of "only just."

To demonstrate the possibly misleading effect of fogging upon the accuracy of the cross-cylinder tests for amount of astigmatism, and also the contrasted effect of active accommodation upon the test, Williamson-Noble caused a well-known London optical house to prepare a series of photographs showing the effect of a half-diopter increase or reduction in the spherical value of the photographic lens.

In the set of photographs based upon the addition of a half-diopter plus sphere to the photographic lens, there is a manifest tendency for the camera to suggest falsely the presence of an astigmatism against the rule; whereas in the set of photographs based upon the addition of a half-diopter minus sphere to the photographic lens there is an equally manifest tendency for the camera to suggest falsely the presence of astigmatism with the rule.

Other illustrations in Williamson-Noble's paper demonstrate, so far as the photographic camera is concerned, the accuracy of the results obtained with the cross cylinder when no spherical modification has been made in the basic focus of the photographic lens.

The present writer, in his original articles on the subject and in many conferences and demonstrations, has repeatedly urged that the best results were obtainable if the patient's eye was not appreciably fogged nor the accommodation appreciably active. He has also, with equal insistence, pointed out that the cross cylinder, especially if loosely and uncritically employed, was capable of overstating astigmatism against the rule or understating astigmatism with the rule. It was never his intention to suggest that best results were obtainable in a fogged eye.

The accommodating eye, does, however, possess one advantage over the photographic camera in that it may, by virtue of its accommodation, still continue to give approximately accurate results such as the photographic camera cannot possibly furnish when its basic focus has been modified by addition of a half-diopter minus sphere.

It may be well to repeat the statement made earlier in this editorial, to the effect that, when it is desired to imitate with the camera the action of the human eye under astigmatic tests, satisfactorily comparable results can only be made by retaining, throughout the various steps of the demonstration, the basic focus of the photographic lens for the test type or other objects at the distance at which the photographs are being made. Modification of such basic focus with a plus or minus sphere has a definite tendency to make the comparison unreliable.

W. H. Crisp.

CROSS-CYLINDER PRIORITY

In the paper by Williamson-Noble which is discussed in the preceding editorial, that author suggests that, because in 1849 the Irish mathematician Gabriel Stokes (later Professor of Mathematics at Cambridge University and President of the Royal Society) devised an arrangement of crossed cylinders for the measurement of refraction, we ought therefore habitually to associate the name of Stokes

with the simple form of cross cylinder to which we have usually attached the name of Edward Jackson.

The piece of apparatus designed by Stokes, and which Donders (see page 485 of the Sydenham Society's English translation) suggested should be called "the astigmatic lens of Stokes," consisted of two cylindrical lenses, one planoconvex of four diopters, the other planoconcave of the same strength, fitted into a single mounting in such a way that any cylindrical strength from zero to eight diopters could be obtained by rotation of one part of the mounting upon the other. Stokes used this combination as a control upon the amount of astigmatism and the position of the astigmatic axis; but he applied the apparatus approximately as modern workers employ a single cylinder, or a succession of single cylinders, turning the whole apparatus to different axes as a check upon the axis, and varying the total strength of cylinder in accordance with the patient's reactions as to distinctness of the test type. Donders, who himself used the Stokes apparatus, remarks that "the method is not very applicable in practice."

As to the suggestion that the modern cross cylinder should be named after Gabriel Stokes instead of after Edward Jackson, it may be remarked that Edward Jackson was never much concerned over any question of priority. So that we might, as we pleased, and without offense, call any crossed cylinder simply "the cross cylinder," or the "Stokes cross cylinder," or the "Jackson cross cylinder." But the wide clinical use of the present much simplified appliance, with the special technique of flopping or twirling the lens into two alternative positions, has arisen from the work of Edward Jackson; and the cross cylinder as we know and use it today, in the practical work of refraction, is Jackson's device and not that of Stokes, even though it may have been suggested in part by the work of the Anglo-Irish mathematician.

W. H. Crisp.

CORRESPONDENCE

Incision for cataract extraction in presence of filtering scar

Editor,
American Journal of Ophthalmology:

My attention has been called to the fact that Dr. Ramon Castroviejo has employed a temporal incision with sutures very similar to those described by me in the last [May] number of your Journal. He employed the method, as I do, for cataract extraction in cases with a filtering scar resulting from a previous trephining or iridencleisis. His article was published in America Clinica, 1942, v. 4, no. 3.

(Signed) Sanford R. Gifford.

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

1

GENERAL METHODS OF DIAGNOSIS

Bhave, L. S. **The slitlamp and the corneal microscope.** Indian Jour. Ophth., 1942, v. 3, April, p. 35.

The author offers his notes on the development and use of these instruments to beginners who are likely to have opportunities to study their cases with the slitlamp and the corneal microscope. The various methods of examination and the findings in normal eyes are described.

Francis M. Crage.

Bogart, D. W. **Kodacolor fundus prints.** Arch. of Ophth., 1943, v. 29, Feb., pp. 278-281.

This is a discussion of the utilization of Kodacolor film in fundus photography. Kodacolor is a form of color photography introduced rather recently by the Eastman Kodak Company. In this process a color negative is made with the colors reversed, and from this color negative any number of color prints may be made. The prints are not transparencies such as are produced by the Kodachrome process. If desired, the color negative may be used in making black and white prints. All of the processing must be done by the Eastman Kodak Company at Rochester, New York. The cost, including film, processing and print is 58 cents a picture. The author discusses the use of this film in the Nordenson camera, using the arc. The technique used in making the film fit an adapter is described. The photographic results have been excellent.

John C. Long.

Friedman, Benjamin. **Entoptic methods in clinical investigations.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 235-244. (2 illustrations, bibliography.)

Lijó Pavía, J. **Cinematography of retina and vitreous, slow-motion tonoscopy, and cinematography of the retinal arteries in color.** Rev. Oto-Neuro-Oft., 1941, v. 16, July, p. 183.

According to the author the first successful cinematographic exploration of the retina took place in Buenos Aires in July, 1932, the film being presented before the Neurologic Society of that city in November of the same year. A

similar presentation by Bailliart occurred in Paris the following month.

The first film was made with eight exposures per second. This was found to represent arterial pulsations too rapidly. Subsequent pictures with a speed of 25 exposures, projected in the ordinary mechanism running 16 per second, produced an almost perfect synchronization with the normal heartbeat.

In 1933 Lijó Pavía, working together with Bailliart, employed a supersensitive film and an automatic camera (thirty exposures per second) in the erroneous belief that this would catch arterial contractions and dilatations in their different phases, giving valuable information regarding manifestations of the arterial circulation and being a step toward verification of the theories and hypotheses of the clinicians and physiologists. Technical details, however, still required ironing out. The year 1936 evolved such advancements and satisfactory results with the utilization of lenses having in one case a dioptric power of twenty and in the other of thirty.

Vitreo-cinematography, or the reproduction of opacities, parasites, blood, and other alterations of the vitreous, is feasible only if such conditions are located within the posterior half of that body. The author's film shows cases of synchysis scintillans, hemorrhage of a rare type, floating membranous folds from the region of rents in the retina, and cysticercus. In the latter condition this method of investigation exhibits one of its most brilliant results. It is possible to note the development of the parasite and its traversing of the choroid and retina to emerge free in the vitreous where the characteristic movements can be visualized in detail.

Tonoscopy has shown us that pulsating movements of the central artery vary according to the age of the patient. A differentiation has been described: in the adolescent the pulsations take place over the bifurcation in the form of "jumps," and in the adult the movement is produced either in the trunk of the artery or in one of its principal divisions if the vessel has divided behind the lamina cribrosa. Although it might seem that analysis of these movements would be quite simple, yet certain problems are almost insoluble. These include the fleeting character of the arterial action, maintenance of uniform pressure on the globe by the Bailliart dynamometer, rigid alignment while the photographer brings the artery into focus, and the defense reflex initiated upon flooding of the interior of the eye with the necessary intense illumination. However, with a camera geared to 62 exposures per second, and utilizing the slow-motion apparatus, fairly uniform results have been obtained. The author feels that much may be expected through the use of this modality in investigation of various heart conditions.

The use of Kodachrome in making a motion picture of the fundus has the advantage of giving most admirably in natural color the changes in retina and choroid. Pulsations of the vessels, their caliber, the movement of the blood column, and so on are more detailed. Above all, observation of the phenomena resulting from compression of the globe may in the future give this application of retino-cinematography a place of some importance.

Solon L. Rhode.

Lijó Pavía, J. **The fundus of the eye under the sodium light.** Rev. Oto-Neuro-Oft., 1941, v. 16, June, p. 141.

This is chapter 17 of a book having the same title and in which are contrasted the results of examination of the fundus under different types of illumination. Comparison is made of the relative values of detail and their dependability in the ophthalmoscopic findings with use of ordinary, red-free, and yellow lights.

Cataloguing numerous observations under each of the following conditions, the author shows that the yellow illumination permits visualization of greater minutiae and more exact evaluation of the changes present: separation of the retina in which reattachment has been effected by surgery; myelinated nerve fibers; degenerative lesions of the macula; primary macular lesions; hole in the macula; hypertensive retinitis; alterations of hypophyseal origin; optic atrophy; recent injury with loss of one eye (examination of the sound eye). In but three cases (simple glaucoma, a supposed alteration in the internal limiting membrane, and choroiditis with detachment of the retina) did the author find that this method offered no advantages over the use of red-free or ordinary light.

Solon L. Rhode.

Payne, B. F. **The diagnosis of ocular syphilis.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 266-270. (References.)

Saubermann, G. B. C. **On the differential sensitivity of the dark-adapted eye.** Ophthalmologica, 1942, v. 104, Sept., pp. 157-165.

The author studied the power of discriminating luminosity differences by means of an apparatus on which colored discs can be rotated. In an outer circular portion a colored ring is exposed for comparison with the brightness of an inner circular disc in which the relative quantities of white and black can be changed during rotation. Differences in luminosity are less easily perceived by the dark-adapted eye, and the difficulty becomes greater as dark adaptation increases. (References.) F. Herbert Haessler.

Sugar, H. S. **Malingering in military ophthalmology.** Military Surgeon, 1942, v. 91, Sept., pp. 314-320.

The author describes the five forms of visual malingering or, better, "volitional blindness" or "volitional amblyopia." There are: (1) simulation of a condition that does not exist, (2) falsification of statements in regard to an alleged condition, (3) exaggeration or overstatement as to the severity of a condition, (4) dissimulation or pretense that an existent condition is not present, and (5) self-inflicted injuries. Sugar describes and discusses in detail the available tests, with actual illustrative examples. T. E. Sanders.

Terry, T. L. **Some clinical applications of fluorescence in relation to melanotic pigment.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 536-539. (2 photographs, references.)

Verhoeff, F. H. **Simple quantitative test for acuity and reliability of binocular stereopsis.** Arch. of Ophth., 1942, v. 28, Dec., 1000-1014; also Trans. Sec. on Ophth., Amer. Med. Assoc., 1942, 93rd mtg.

For testing binocular stereopsis the author has devised an instrument consisting of a rectangular black screen in which are windows of various sizes separated by black strips. Some of these strips are 2.5 mm. behind the others. Various combinations are obtained by varying the strips on the black screen and by inverting the in-

strument. The misleading size differences of the windows make binocular parallax the only correct evidence of relative depth. The usual test subject has less than one chance in five million of passing the test by guessing, and even a practiced cheater has less than one chance in 65 thousand. A system for quantitatively grading acuity of stereopsis has been devised, somewhat analogous to the Snellen system for grading visual acuity. The test is simply and rapidly conducted without the use of any viewing instrument. The author regards it as the best means now available for determining as far as stereopsis is concerned a subject's fitness for aviation or other occupations in which this factor is important. (One illustration, references.)

John C. Long.

2

THERAPEUTICS AND OPERATIONS

Baer, A. J. **The vitamins in ophthalmology.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 286-291. (Bibliography.)

Braley, A. E. **Sulfonamides in the treatment of ocular infections.** Ohio State Med. Jour., 1942, v. 38, Dec., p. 1101.

The author summarizes the toxic reactions caused by peroral use of the sulfa drugs. He finds sulfapyridine the most toxic, sulfanilamide and sulfathiazole less, and sulfadiazine the least toxic drug. Thus the last is preferred for oral use. But a test in vitro will show which of the sulfonamides has the greatest bacteriostatic effect on a given strain of organism, and this drug should be selected for therapy. The dose of sulfanilamide is ⅓ gr. per pound of body weight and the blood level should be held at 4 to 10 mg. per 100 c.c. (4 to 9 mg. in case of sulfapyridine). The ointment should be applied every four hours on the lid margin and in the culdesac. On marginal ulcers the sulfonamides should be dusted in the form of a powder.

Tabulating the results attained in 153 ocular infections the author finds that peroral sulfonamides are of greatest value in the treatment of gonococcus infections, trachoma, inclusion conjunctivitis, lymphogranuloma venereum, influenza conjunctivitis, and hemolytic streptococcus infections. Peroral treatment is of some value in staphylococcus and pneumococcus infections and in pyocyaneus ulcers, but combination with local therapy will increase its value. Local therapy is indicated in blepharitis, impetigo, and various ulcers, and furthermore in staphylococcus, pneumococcus, and influenza conjunctivitis and in inclusion conjunctivitis in infants.

Sulfonamides are apparently of no value in the treatment of nonhemolytic streptococcus infections, tuberculosis, tularemia, Parinaud's conjunctivitis, ocular pemphigus, uveitis, sympathetic ophthalmia, and typical virus infections, such as dendritic keratitis and herpes zoster. R. Grunfeld.

Elvin, N. C. **The pH and tonicity of ophthalmic solutions.** Arch. of Ophth., 1943, v. 29, Feb., pp. 273-277.

The ideal solution to be dropped into the eye should have a pH of 7.4 and should be isotonic with a 1.4-percent solution of sodium chloride. Such a solution would resemble normal tears in both hydrogen-ion concentration and in osmotic pressure. The more nearly a solution approximates this ideal the less irritating will it be and the more nearly adequate will be its absorptive and therapeutic effects. As a striking

example of the effect of pH on the rate of absorption it has been shown that when the pH of a 1-percent solution of cocaine hydrochloride was increased from 3.2 to 8.7 there was a sevenfold increase in its rate of absorption, with resultant improvement in anesthetic properties. Not all drugs will stay in solution at the ideal hydrogen-ion concentration, so certain modifications must be made. A list is given showing the concentration of commonly used eye solutions isotonic with tears and a formula for the adjustment of tonicity of these solutions. The method of determining the pH of solutions with indicators is explained. John C. Long.

Engel, Sam. **Reflection on the clinical use of atropine.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 297-301. (References.)

Hathi, H. G. **Sulfanilamide in eye diseases.** Indian Jour. Ophth., 1942, v. 3, July, p. 71.

Sulfanilamide was used with good results in trachomatous pannus, acute Koch-Weeks conjunctivitis, membranous conjunctivitis, acute purulent conjunctivitis with gram-negative intracellular diplococci and pneumococcic and staphylococcic conjunctivitis. In operated cases of dacryocystitis, in postoperative sepsis, in sloughing and trachomatous ulcers, and in acute catarrhal corneal ulcers, the drug was also used with good results.

Gertrude S. Hausmann.

Laval, Joseph. **Paresis of accommodation following sulfadiazine therapy.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 303-304.

Robson, J. M., and Scott, G. O. **Local chemotherapy in experimental lesions of the eye produced by Staphylococcus aureus.** The Lancet, 1943, v. 244, Jan. 23, p. 100.

A method is described which allows the production of rather uniform Staphylococcus-aureus lesions of the rabbit cornea. A technique is thus available for testing the value of drugs in the treatment of localized lesions.

Definite beneficial effects on the development of the lesions were produced by local application of (a) penicillin, and (b) 30-percent and 10-percent sodium sulfacetamide. A 15-percent solution of solubilized sulfathiazole was less effective, and tyrothricin was of little or no value. In all these experiments, treatment was begun one hour after inoculation. When treatment was begun 24 hours after inoculation, little or no benefit was produced by application of penicillin or sodium sulfacetamide.

The results of these experiments suggest that penicillin and sodium sulfacetamide are of value in prophylaxis, and of less value for treatment unless begun early. An interesting finding was that penicillin eliminated Staphylococcus aureus from the conjunctival sac, but that this was not achieved by sodium sulfacetamide although clinically the effect of the two drugs on ulcers was equal. J. Wesley McKinney.

Rutherford, C. W. **Chemotherapy in ophthalmology.** Jour. Indiana State Med. Assoc., 1942, v. 35, Dec., p. 697.

The history of the sulfa drugs is reviewed. The complications occurring during their administration are discussed. Among ocular complications are retinal hemorrhage, transient myopia, and optic neuritis. Attention is called to the use of ointments of the drugs for local treatment. As main advances through ocular treatment with

sulfa drugs Rutherford cites the control of B. pyocyaneus ulcer of the cornea and better management of gonorrheal infection. In trachoma, Rutherford finds the best effects of sulfanilamide treatment in exacerbative cases and in corneal lesions, and the least in follicular and papillary changes. Sulfanilamide alone was found of questionable value in uncomplicated cases, but appeared efficient in clearing up complications, especially those associated with stage three. In discussion, Gradle disagrees with Rutherford in the evaluation of the sulfa drugs for the treatment of trachoma. He stresses the enormous value in trachoma I and II. He states that after four days of treatment with sulfanilamide the inclusion bodies disappear from the conjunctiva, which means that those cases can no longer spread the disease. Gradle says further that 50 percent of the entire population of the world is infected with trachoma but he thinks that with the use of sulfa drugs over a period of twenty years the disease could be wiped out.

Gertrude S. Hausmann.

Windham, R. E. **Sulfanilamide drugs in ophthalmology and otolaryngology.** Texas State Jour. Med., 1942, v. 38, Nov., p. 451.

A brief review of the use of the sulfonamides in several ophthalmologic and otologic conditions.

3

PHYSIOLOGIC OPTICS, REFRACTION, AND COLOR VISION

Beach, S. J. **Anisocycloplegia.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 522-524.

Berens, Conrad. **A confirmation test for refraction.** Amer. Jour. Ophth., 1943, v. 26, March, p. 297; also Trans. Amer. Ophth. Soc., 1942, v. 40. (One illustration.)

Boshoff, P. H. **Use of zelex in making impressions of the eye for molded contact glasses.** Arch. of Ophth., 1943, v. 29, Feb., pp. 282-284.

Factors involved in making impressions of the cornea and sclera are pointed out. The disadvantages of wax and negocoll as molding agents are discussed and the use of a new material, zelex, is described. Zelex is a "flexible colloidal material" employed in dentistry. It is a fine pinkish powder which dissolves easily in water and sets quickly into a firm elastic mold. The author describes the simple technique employed in using this material. The elasticity of the mold prevents permanent deformation of the impression when it is removed from the eye. (References.)

John C. Long.

Burian, H. M. **Clinical significance of aniseikonia.** Arch. of Ophth., 1943, v. 29, Jan., pp. 116-133.

This clear and comprehensive statement of the subject may be read with advantage by either oculist or internist.

The two eyes are never identical. Between them there are always numerous discrepancies as to the neuromuscular apparatus, the dioptric system, and the sensorial apparatus. Indeed, some incongruities are the necessary basis for normal binocular vision and depth perception. But when these incongruities exceed a certain amount they present a more or less serious obstacle to fusion and may produce pathologic symptoms requiring treatment. The present paper discusses aniseikonia as one of these incongruities.

Differences in the ocular images may be caused by differences in the

dioptric images as in anisometropia. It is a new concept that a difference in the size of the ocular images may also exist in cases in which there is no difference in the size of the dioptric images. This type of difference may be termed basic aniseikonia in contradistinction to a refractive aniseikonia. A patient may have both of these types of differences.

Aniseikonia is a general term covering all the incongruities of the ocular images; they may vary both in size and shape. Every one has some aniseikonia, but whether symptoms arise depends on tolerance to the differences. There are no pathognomonic symptoms; in general they are the usual asthenopic complaints. Certain effects, however, are seen more frequently, namely, photophobia, photophobia with headache, and trouble in viewing moving objects. The greater the number of symptoms the greater the likelihood of aniseikonia.

The asthenopic symptoms from correction of anisometropia are due both to difference in prismatic effect and to difference in size of ocular images. The anisometropia and aniseikonia may not be proportional.

Several case reports are cited in which aniseikonic lenses were prescribed. One was an emmetrope with 20/15 vision in each eye but with 2-percent difference in the vertical meridian; his headaches and nausea of many years standing disappeared upon correction. Another man complained of headache and eyestrain on close work, and he had diplopia when given full vision for each eye with correction of −6.75 D. sphere for the right eye and +1.00 D. cylinder for the left eye. He had three prism diopters of hyperphoria and marked image difference. This high anisometrope obtained complete relief with the aniseikonic correction incorporated into the full strength refractive lenses, although the hyperphoria was not corrected with a prism. A high school boy complained of general fatigue after close work. It was found that he had anisometropia and aniseikonia and that he had no depth perception with his ordinary lenses. Upon addition of the aniseikonic correction his fusion was 100 percent.

Both aniseikonia and heterophoria result in fusional difficulties. The clinical picture is dominated in certain cases by heterophoria and in others by aniseikonia. Only by trial can one tell whether one or the other or both need to be corrected. As to selection of cases, if a patient does not obtain relief from his symptoms by correction of his refractive error and his muscular inbalance, and if other physical causes have been excluded, there is good reason to believe that an aniseikonic correction may benefit him. It has been suggested that occlusion of one eye might be used as a presumptive test, but this is unreliable.

The author believes that aniseikonia is as universal as the errors of refraction, but a correction is not warranted unless its amount is clinically significant. The general experience is that a size difference of 1 percent is significant. In the practical aniseikonic problem it is a basic fact that such an apparently small amount of size difference is capable of producing symptoms. The usual amount found in clinical cases varies from 1 to 2 percent. Aniseikonia of over 3 percent entails as a rule a definite impairment of binocular vision. More than 5 percent is found only in cases in which binocular vision is very imperfect.

In statistics published by various authors there is striking agreement as to results achieved with iseikonic lenses; the percentage of beneficial results being put at about 70. It is of interest to note that the aniseikonic measurements of patients whose condition was followed over a number of years showed remarkable constancy. This makes it improbable that the favorable results obtained are due to psychologic factors, as sometimes claimed. (6 figures, 4 tables, references.)

Ralph W. Danielson.

Burian, H. M., and Ogle, K. N. **A study of aniseikonia in a case of increasing unilateral index myopia.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 480-490. (6 figures, 2 tables, references.)

Cadan, Henry. **Congenital color blindness.** Med. Record, 1943, v. 156, Jan., p. 21.

The article, making no claim as to cure of congenital color blindness, is written solely to encourage constructive research in color blindness in order that color defectives, prevented from pursuing those fields of endeavor for which they are otherwise best qualified, may be rehabilitated.

Forty-five military rejects suffering from mild red-green blindness were treated with vitamin A and vitamin-B-complex subcutaneously and orally, tincture of iodine orally every day, faradism and sinusoidal current locally, and intensive study of colors and color patterns. After six to 15 treatments, 35 passed reëxaminations in various branches of the military service. The equipment used included Edridge-Green lights, worsted yarns, and the charts of Stilling and Ishihara. Those found normal still showed normal color perception in July, 1942, six months after finishing the treatment.

F. M. Crage.

Craig, P. C. **Ophthalmic surgeon's spectacles.** Arch. of Ophth., 1943, v. 29, March, pp. 485-486.

In order to have lenses for the varied work imposed on one's eyes in an office, the author designed trifocals which were made as follows: A straight-top fused bifocal lens was ground with a segment 14 mm. high (from the bottom of the lens) for a focus of 33 cm. This segment was decentered inward as necessary. A rectangular segment 6 mm. high and 14 mm. wide (containing sphere and prism base in) was ground and cemented so as to extend downward from the line dividing the normal reading and distance portions of the lens, leaving a distance section about 20 mm. high, The second segment was decentered inward 6 mm. In Craig's case the lenses had a +1.00 add in the lower fused segment, and in the middle cemented segment an additional +3.00-D. sphere combined with 3 prism-diopters base in. (Diagram.)

Ralph W. Danielson.

Gokhale, A. M. **Contact glasses.** Indian Jour. Ophth., 1942, v. 3, July, p. 65.

There are three types of contact lens, ground, blown, and molded. In the author's experience the molded contact lens is the one most generally accepted. Contact lenses are advised in cases of irregular and conical cornea, and in monocular aphakia.

Gertrude S. Hausmann.

Harding, G. F. **Devices to aid refraction.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 407-408. (One illustration.)

Laval, Joseph. **Paresis of accommodation following sulfadiazine therapy.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 303-304.

Livingston, P. C., and Bolton, B. **Night visual capacity of psychological cases.** The Lancet, 1943, v. 244, Feb. 27, p. 263. (See Section 17, Systemic diseases and parasites.)

Munson, E. S. **Emmetropia.** Arch. of Ophth., 1943, v. 29, Jan., pp. 109-115.

In this controversial and provocative paper, the author gives many accepted and interesting definitions of emmetropia, all similar to that advanced by Donders in 1864, namely: "The emmetropic eye is that, the principal focus of whose dioptric system is, in rest of accommodation, found in the retina."

Munson repeats the argument that ciliary-body tonus should be taken into consideration in obtaining a concept of emmetropia. This tonus is measured by the amount of relaxation produced by a cycloplegic, as compared with the refraction shown when the effect of the cycloplegia has worn off. Munson regards this amount as 1.00 D., producing 1.00 D. more than the manifest hyperopia and 1.00 D. less in myopia. He suggests that latent hyperopia should be distinguished from tonus. He believes that with a subject under cycloplegia an additional 1 D. is found which is to be added to the amount of manifest hyperopia to make what is considered the total hyperopia. He would make a distinction between tonus and accommodation. He proposes this definition: "Emmetropia is the refractive state of the eye when rays of light parallel to the principal axis of the dioptric system are focused on the retina when acted on only by normal tonus of the ciliary muscle." "Thus," we are told, "during cycloplegia there is no state that can be called emmetropia."

Ralph W. Danielson.

Peskin, J. C. **The regeneration of visual purple in the living animal.** Jour. Gen. Physiology, 1942, v. 26, Sept. 20, p. 27.

Accumulation of visual purple in the retina after bleaching by light has been studied in the intact eye of the frog. Regeneration of the visual purple is recorded under varying conditions of light intensity and duration and at different temperatures.

Comparative studies are made of the amounts of vitamin A and retinene contained in the intact eyes and in the isolated retinas. F. M. Crage.

Plant, Alfred. **Eyeglasses to be used with the binocular microscope.** Jour. Laboratory and Clin. Med., 1943, v. 28, March, p. 756.

In order to enable the observer to obtain the advantages enjoyed by one not wearing glasses the upper portion of each lens is removed, leaving a crescent 1.3 cm. high with concave edge upward. J. Wesley McKinney.

Sloane, A. E. **Refraction clinic.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 408-410.

Vázquez Barrière, A. **Sudden changes of ocular refraction from internal causes.** Arch. Uruguayos de Med., Cirugia, y Especialidades, 1942, v. 21, Oct., p. 435.

The article deals particularly with the well-known changes occurring in diabetes and those arising after intravenous injection of arsenical drugs.

The refractive changes observed in diabetes have varied from 9 D. of myopia to 4 D. of hyperopia, the hy-

peropic change, however, being much less frequent. Changes of this kind were formerly recorded in as many as 4 percent of the cases of diabetes. They have frequently been a source of embarrassment to the ophthalmologist who failed to appreciate their cause. They are usually explained as due to modification of the refractive index of the crystalline lens, and no such case has been recorded in an aphakic eye. The effect on the lens has been attributed by some writers to concentration of glucose in the lens substance. Others regard the change as being produced rather by variation in the concentration of chlorides. Still others have explained the concentration of chlorides as a retention resulting from concentration of glucose. But it is arguable that the concentration of chloride or glucose necessary to cause some of the greater refractive changes encountered would be incompatible with life. Some authors have suggested that the refractive change is not limited to the crystalline lens but involves also the aqueous and vitreous. The present author reports a personal case in which the change amounted to 5 D. in the direction of myopia. The patient had a previously undiagnosed diabetes.

Since the introduction of arsenobenzol and related drugs there have been reports of a number of cases in which the toxic effects of the arsenical included a transitory myopia, sometimes considerable in amount. Some authors suggested that the change was due to an allergic spasm of accommodation, but this interpretation was controverted by cases in which the condition was not overcome with a cycloplegic, and by the further fact that the complication was sometimes observed in patients of advanced age, the amount of whose accommodation was inadequate to explain such an increase of refraction. Vázquez Barrière reports a case, in a man of 33 years, in which he attributes the myopic change to allergic edema of the crystalline lens. In a number of the cases reported the ocular change and the other toxic symptoms developed only after a number of consecutive doses of the arsenical drug.

Vazquez Barrière adds one to a number of previously reported cases in which similar myopic changes were observed after administration of heavy doses of sulfa drugs. The patient whose case is now reported was a woman of 27 years. The temporary myopia of 5.50 D. in each eye diminished rapidly after withdrawal of the drug. Spasm of accommodation was excluded by comparing the amplitude of accommodation during the temporary myopia with that found after the eyes had returned to normal. Thus it appears that the myopic change must have been due to a change or changes in refractive index.

W. H. Crisp.

Williamson-Noble, F. A. **A possible fallacy in the use of the cross cylinder.** Brit. Jour. Ophth., 1943, v. 27, Jan. pp. 1-12.

The author believes that the cross cylinder should be known as the Stokes lens since the general principles of crossed cylinders were first described by Stokes in 1849.

The fallacy which the author points out is the tendency to overcorrection for astigmatism. To overcome this tendency, an accurate retinoscopy is essential. The duochrome letter test and the Tweedy cross are recommended as two good methods of checking the amount of astigmatism. (10 illustrations, references.)

Edna M. Reynolds.

4

OCULAR MOVEMENTS

Abraham, S. V. **Near-horizontal phoria and duction tests.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 271-279. (3 tables, references.)

Abraham, S. V. **The convergence function in relation to the basal metabolism.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 400-404. (One table, references.)

Bender, M. B., and Weinstein, E. A. **Functional representation in the oculomotor and trochlear nuclei.** Arch. Neurology and Psychiatry, 1943, v. 49, Jan., p. 98. (See Section 19, Anatomy, embryology, and comparative ophthalmology.)

Berens, C., and Loutfallah, M. **Resection of the left inferior oblique muscle at its scleral attachment for postoperative left hypotropia and left pseudoptosis.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 528-533. (One illustration, references.)

Lancaster, J. E. **Orthoptics; education in binocular skill.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 463-467.

Linksz, Arthur. **Objectives of orthoptic examination and treatment.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 552-558. (References.)

MacRae, Alex. **Defective movements of eyes associated with almost complete absence of lacrimal secretion.** Trans. Ophth. Soc. United Kingdom, 1941, v. 61, p. 239.

This combination was encountered in a girl aged 16 years. She could only look at an object to the side by turning her whole head in that direction. There was complete absence of outward or inward movement of the right eye. The left eye had no outward movement. In attempting to look to the right this eye turned a little inward and upward. The following defects were thus suggested: absence or complete paralysis of each external rectus and of the right internal rectus; weakness or partial paralysis of the left internal rectus. There was also absence or complete inactivity of the right lacrimal gland. Excessive close work caused formation of thick strings of mucus which had to be pulled out. No embryologic or developmental explanation could be determined.

Beulah Cushman.

Mathewson, W. R. **Voluntary convergence.** Brit. Jour. Ophth., 1943, v. 27, Jan., pp. 34-35.

A system of training voluntary convergence by alternately raising and lowering prisms in a trial frame is recommended by the author.

Edna M. Reynolds.

Pascal, J. I. **Memory aids in the measurement of strabismus.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 302-303.

Payne, B. F. **An operation for the correction of paralytic lateral-rectus palsy.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 390-393. (One illustration, references.)

Quereau, J. V. D. **The management of squint in children.** Pennsylvania Med. Jour., 1942, v. 46, Nov., p. 112.

After getting pertinent information on the history of the case, the author wants to find out whether the little patient is really affected by a squint and whether this is paralytic or concomitant. The attention of the patient is called to a light which is moved in six cardinal directions, taking notice at

the same time whether any limitation exists in the movement of either eye. If a limitation exists, is the secondary deviation greater than the primary? Is there alternation? In a case of concomitant squint, a 0.25-percent solution of atropine is used for three days in order (1) to refract the patient's eyes by retinoscopy, (2) to examine the fundus for any macular lesion, and (3) to relax the accommodation so as to determine whether the squint originates from a disturbance of accommodative effort. If the squint disappears under the use of atropine, glasses are prescribed and no operation is performed. For amblyopia ex anopsia, if the child is not older than six years (after that age the response is poor), exercises are used by the occlusion method or by the use of atropine, alternating with the other eye at two-week intervals or less if the vision improves. In prescribing glasses, a correcting prism is added to the full refraction if a vertical deviation is present. The author remarks (1) that orthoptic treatment is to be used in order to develop the power of fusion and stereopsis (in the opinion of Worth squint is a faulty fusion faculty), (2) that in alternating convergent squint fixation is maintained with either eye and amblyopia does not develop and thus orthoptic exercises are useless, and (3) that divergent squint develops at about the age of ten years and its treatment is essentially operative. A table suggesting the type of operation or a combination of operations, according to the degree of squint, is included in the text.

Melchiore Lombardo.

5

CONJUNCTIVA

Contardo, R., Peralta, A., and Arentsen, J. **Phlyctenular conjunctivitis in school environment.** Rev. Chilena de Higiene y Med. Preventiva, 1942, v. 5, June, pp. 5-16.

Among 7,200 children examined by the health department, 376 had phlyctenular keratoconjunctivitis (5.22 percent). These patients were tested as to tuberculin reaction, radiologic findings, and sedimentation rate. The frequency of the eye disturbance followed a seasonal curve, being more frequent in the spring. Of the cases with negative radioscopy, 66 percent gave a positive reaction to tuberculin. Of those with positive radioscopic findings, the corresponding percentage was 92.63. The sedimentation rate was 60 percent in the cases with pulmonary lesions and 71.4 percent in the cases with positive radioscopy. Phlyctenulosis occurred more frequently in children whose general condition was poor. The authors regard phlyctenulosis as in most cases due to a specific tuberculous allergy. (References.) W. H. Crisp.

Gallardo, E., and Hardy, L. H. **Virus isolated from pemphigus-like keratoconjunctivitis.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 343-353. (2 figures, 3 tables, references.)

Julianelle, L. A. **Studies on the infectivity of trachoma. 12. Additional observations on the cultivability of the virus.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 280-282. (References.)

Julianelle, L. A. **Studies on the infectivity of trachoma. 13. Further experiments on the antigenicity of the virus.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 378-381. (References.)

Julianelle, L. A., and Moore, E. **Pathological changes in listerella infection, particularly of the eye.** Amer.

Jour. Path., 1942, v. 18, Sept., p. 813.

The authors studied changes in the ocular response of animals infected with listerella. They report an inflammatory response in the conjunctiva and cornea with appreciable involvement in the deeper structures. Edema of the involved structures is a prominent feature at the height of the infection. Vascularization of the cornea develops concomitantly with the other evidences of inflammation. The eye generally heals with scarring two or three weeks after instillation of the organisms.

Theodore M. Shapira.

Kirby, D. B. **Electro-surgical excision of pterygium.** Amer. Jour. Ophth., 1943, v. 26, March, pp. 301-302.

Kuh, Clifford. **Epidemic keratoconjunctivitis: "shipyard eye."** California and Western Medicine, 1943, v. 58, Jan., p. 18.

In the author's experience epidemic keratoconjunctivitis ran a milder course in 1942 than in 1941. The symptoms lasted only a few days instead of weeks as was the case in 1941. The main symptoms were irritation, scratching in the eye, lacrimation, photophobia, and dull pain in the eyeball. Various degrees of inflammation and hyperemia of the bulbar and palpebral conjunctiva, occasional edema, and subconjunctival hemorrhage were noted. The preauricular lymphatic glands were swollen. Some patients developed multiple minute opacities of the cornea, but the ultimate prognosis as to vision was good. Iced compresses are suggested for symptomatic relief. Constant covering of the eye, and sulfathiazole and sulfadiazine ophthalmic ointment to prevent secondary infection, are recommended. The causative agent may be a virus. Direct transfer is necessary for infection. The incubation period is from 5 to 12 days. Preventive measures to be taken in plants and shipyards are enumerated.

R. Grunfeld.

Lever, W. F. **Pemphigus conjunctivae with scarring of the skin.** Arch. Dermat. and Syphil., 1942, v. 46, Dec., pp. 875-880.

Scarring is always found in pemphigus of the conjunctiva, but is extremely rare in pemphigus of the skin, except following infection, there being only five cases in the literature. The author reports three additional cases of pemphigus conjunctivae with scarring of the skin as well as of the mucous membranes.

T. E. Sanders.

Levy, G. J., and Lewis, P. M. **Use of sulfonamides in treatment of gonococcic conjunctivitis.** Jour. Tennessee State Med. Assoc., 1942, v. 35, Nov., pp. 417-420.

A series of 137 patients with gonococcic conjunctivitis treated with the sulfonamides is reported. Ninety cases were treated with sulfanilamide, with an average duration of 5.4 days and unsatisfactory results in eight cases. Using sulfapyridine, 22 were treated with no unsatisfactory results and an average duration of 2.57 days. The series treated with sulfathiazole included 25 patients, with a duration of 3.8 days and poor results in one case. A control presulfonamide series of 50 cases showed an average duration of 17.3 days with unsatisfactory results in 18 cases. With the exception of one case early in the series toxic reactions were negligible. The local use of 5-percent solution of sodium sulfathiazole has proved to be of definite value, but in effectiveness it does not compare favorably with internal use. For every

case of gonoccocic conjunctivitis the authors recommend adequate systemic treatment, with sulfathiazole 5-percent solution used locally as an adjunct.

T. E. Sanders.

Neira Salgado, M., and Ahumada, R. R. **Radiological and clinical study of phlyctenular conjunctivitis in school environment.** Rev. Chilene de Higiene y Med. Preventiva, 1942, v. 5, June, pp. 47-81.

This article is along lines somewhat similar to those of the paper by Contardo, Peralta, and Arentsen; but it is much longer and contains a great profusion of graphs showing statistical analysis of the cases with regard to occurrence in preschool or school age, incidence from year to year of age, presence of active or dormant tuberculous infection, and radiologic findings. The authors conclude that phlyctenular conjunctivitis is a local manifestation of tuberculotoxic character, disseminated through the bloodstream; in other words, a phenomenon of specific allergy. (References.)

W. H. Crisp.

Poleff, L. **The question of the Weil-Félix reaction in trachoma.** Ophthalmologica, 1942, v. 104, Sept., pp. 121-136.

In the blood of trachoma patients the Weil-Félix reaction, which is an agglutination phenomenon, often occurs in serum of fairly low titer. Weigl's reaction (agglutination of rickettsia Prowazek) also occurs, but trachoma serum hardly agglutinates rickettsia Rocha-Limae at all. Because of the paraspecific character of these group reactions in trachoma it is very important to follow meticulously all details of the methods employed. Since even normal serum, not too greatly diluted, may contain X-agglutins, the Weil-Félix should not be called positive in too low a titer, say under 1 to 100. The trachoma virus and the pathogenic agents of certain other rickettsioses produced agglutinins that have some family resemblances. One must be cautious, however, as to concluding that trachoma is a rickettsia. (Bibliography.)

F. Herbert Haessler.

Price, Dorothy. **The tuberculous etiology of the conjunctival phlycten.** Trans. Ophth. Soc. United Kingdom, 1941, v. 61, p. 264.

All of 36 patients with conjunctival phlyctenulosis examined by the author gave a positive tuberculin reaction. Radiologic evidence of tuberculosis was found in 27 out of 33 cases which were classed as pulmonary. According to the author, the phlycten appears during the healing stage of primary tuberculosis, between five months and two years after the primary infection, with an average of nine months.

Beulah Cushman.

Sanders, M., and Alexander, R. C. **Epidemic keratoconjunctivitis.** Jour. Exper. Med., 1943, v. 77, Jan. 1, pp. 77-95.

This epidemic form of keratoconjunctivitis has gained prominence and importance in recent years because of its high incidence in our shipyards and other places where war workers are concentrated in great numbers. The infection is of specific etiology and can be differentiated from other corneal and conjunctival infections. In the Institute of Ophthalmology, where the authors conducted parts of their research, the criteria considered characteristic of epidemic keratoconjunctivitis are as follows: an acute follicular conjunctivitis with scanty exudate,

preauricular lymph-node enlargement and tenderness, negative bacteriology, mononuclear cellular exudate, and punctate keratitis with lesions of varying size.

The present report may be divided into two parts: first, the study of the virus itself, technique of isolation, effect of the virus in laboratory animals, its activity in tissue culture, and its apparent size (based on ultrafiltration experiments); second, identification of the virus by neutralization tests, by reproduction of typical keratoconjunctivitis through inoculation of the mouse agent into the human eye, and by tests for exclusion of certain viruses common among laboratory animals. The technique of isolation is described in detail and the text illustrated by case histories, diagrams, and tables. The pathologic changes in mice were limited to the central nervous system. As to the particle-size of the virus, it passed easily through an E-K Seitz filter and through all grades of Berkefeld filters. Graded collodion membranes with an A.P.D. of less than 50 millimicrons retained the virus, incidentally indicating a size considerably smaller than the viruses of rabies and herpes (125 millimicrons).

Neutralization tests of mouse keratoconjunctivitis virus on various types of serums yielded consistent results, and definite neutralization of at least 10,000 mouse-infection doses was obtained, in studies of the serum of a patient recovered from keratoconjunctivitis. A summary of neutralization tests based on studies of seven human convalescents makes it clear to the authors that there is a definite relationship between the two strains of mouse keratoconjunctivitis virus and the serum of patients convalescent from the human disease. Three of the serums were of especial interest because they came from patients in California who suffered with the disease during the winter epidemic of 1941. The bleedings were done one to six months after the onset of the disease. Included in the controls were various antivirus serums, those from normal persons and those from seven patients suffering from conjunctivitis or keratitis other than the epidemic form.

Since the present study was concluded, serums from 15 patients suffering from keratoconjunctivitis (diagnoses made by Thygeson) in a localized epidemic in New York City have been tested for neutralizing antibodies, using the technique described in this report. The results closely paralleled those described by the authors. In six cases it could be determined that serum taken at the height of the disease contained no antibodies, but that they were definitely present a few weeks later. The specific relationship between the virus and the human disease was further evidenced by the transfer of the mouse virus to the eye of a human volunteer, with the reproduction of a mild but characteristic human disease. (7 plates.)

Jerome B. Thomas.

6

CORNEA AND SCLERA

Basu-Chosdhary, T. C. **Treatment of corneal ulcer.** Indian Jour. Ophth., 1942, v. 3, July, p. 77.

The most frequent causes of corneal ulcer are reviewed. The principles of treatment are pointed out.

Gertrude S. Hausmann.

Busacca, A. **Is urotropine a specific cure for corneal herpes?** Anales Argentinos de Oft., 1942, v. 3, Jan., Feb., March, p. 3.

Four cases of herpetic lesions of the cornea are reported. They healed with great rapidity when urotropine was employed. The dose was 2 gms., intravenously each day for four days. The author reports that in a cicatricial pannus, where there is segmentation of the blood stream, the drug induces a normal flow. (18 figures.)

Eugene M. Blake.

Cogan, D. G. **Clearing of edematous corneas by glycerine.** Amer. Jour. Ophth., 1943, v. 26, May, p. 551. (References.)

Conway, J. A., and Loewenstein, A. **A third entity of primary symmetrical fatty corneal dystrophy.** Brit. Jour. Ophth., 1943, v. 27, Feb., pp. 49-54.

A case of primary symmetrical interstitial fatty corneal dystrophy with lipoidal arc due to nephrotic lipemia is reported. The outstanding characteristics were (1) a broad lipoidal arc with an irregular lucid interval between the arc and the sclera, and (2) infiltration of the entire cornea with small grayish-white fatty droplets. The establishment of fatty infiltrates within the peripheral corneal fibers is considered as interfering with the proper filtering action of this part of the cornea. (3 illustrations.)

Edna M. Reynolds.

Cuillé, E. F. **A simple apparatus for treatment of ulcers of the cornea with hot air.** La Semana Med., 1943, v. 50, March 11, p. 566.

A curved tube, with a slightly bulbous extremity, is connected with what the author calls a Richardson bulb, of the type formerly much in use to maintain steady air pressure for spraying and other purposes. A firm rubber bulb serves for compression by the hand, and the second bulb, of soft thin rubber and retained within a net, provides the uniformity of air pressure. The soft rubber bulb is first dilated and the air pressure retained temporarily by a clamp on the rubber tube connecting the bulb with the metal tube. The tip of the metallic tube is heated to redness. A stream of air is then permitted to pass through the heated tip on to the corneal ulcer. The heat of the current of air may be judged by its ability to scorch a sheet of paper held 2 mm. from it.

W. H. Crisp.

Gallardo, E., and Hardy, L. H. **Virus isolated from pemphigus-like keratoconjunctivitis.** Amer. Jour. Ophth., 1943, v. 26, April, pp. 343-353. (2 figures, 3 tables, references.)

Green, John. **Severe kerato-iritis due to brucellosis: successful treatment with brucella abortus vaccine.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 491-498.

Hamilton, J. B. **Notes on forms of keratitis presumably due to the virus of herpes simplex.** Brit. Jour. Ophth., 1943, v. 27, Feb., pp. 80-87.

The author feels that a bacterial keratitis can be distinguished clinically from the virus type with ease. A virus simplex keratitis has several cardinal clinical features. (1) This particular type of infection often follows a true or artificial pyrexia. (2) The relapsing nature of herpes-simplex keratitis has impressed itself on everyone. (3) There is a total absence of acute iritis and a very small amount of conjunctival discharge. (4) Corneal lesions may range from multiple corneal erosions to disciform keratitis. (5) Lesions of the lids are not uncommon. (6) Cultures of the conjunctival sac invariably show "no growth" or normal saprophytes. (7)

If the case is treated correctly, recovery is rapid and the visual result excellent.

According to the author, omission of heat in any form is of paramount importance in treatment. Ice compresses are valuable. Artificial pyrexia is also contraindicated. Because herpes simplex does not cause iritis, the use of atropine is unnecessary. Autoinoculation is not practicable unless there is also a skin lesion. Mild tincture of iodine is efficacious in drying up lip lesions. Pure carbolic acid is used by the author for dendritic ulcers and 2-percent silver nitrate in marginal and superficial punctate keratitis. (2 tables, 6 drawings, references.)

Edna M. Reynolds.

Julianelle, L. A., and Moore, E. **Pathological changes in listerella infection, particularly of the eye.** Amer. Jour. Path., 1942, v. 18, Sept., p. 813. (See Section 5, Conjunctiva.)

Kuh, Clifford. **Epidemic keratoconjunctivitis: "shipyard eye."** California and Western Med., 1943, Jan., p. 18. (See Section 5, Conjunctiva.)

Leahey, B. D. **Corneal transplantation.** New England Jour. Med., 1943, v. 228, March, p. 387.

The author reports ten cases of keratoplasty in all of which the Castroviejo technique was followed. In four of the cases ability to read ordinary book print resulted, though no patient had better than 20/70 vision. Before operation, all the cases had been classified as unfavorable.

J. Wesley McKinney.

McBain, E. H. **Hereditary corneal dystrophies.** Arch. of Ophth., 1942, v. 28, Dec., p. 1020.

Hereditary corneal dystrophies have been classified into three types by Bucklers. The first and commonest type is granular or crumb-like corneal dystrophy. This is a Mendelian dominant. The condition begins about the time of puberty with the development of delicate dots and fine radiating lines in the superficial layers of the stroma and in Bowman's membrane. There is a gradual enlargement of the infiltrations with coalescence and thickening. The process is slow and moderately good vision often remains in the fifth decade. The second type, macular corneal dystrophy, is a recessively inherited disease. It begins in the first decade as a more or less diffuse and rapidly progressive opacity of the whole cornea. Visual acuity suffers early and the patient often becomes practically blind at the age of 30 years. The rarest of the types is lattice-like corneal dystrophy. This is a dominant disease that usually begins at the time of puberty as a system of double-contoured lines which bifurcate and cross one another in the anterior part of the stroma. The cornea becomes irregular and acuity may be considerably diminished by the third decade. The lesions of all three types develop simultaneously in both eyes in a more or less symmetrical manner. The lesions always involve the parenchyma and progress throughout life. There is no vascularization. Treatment has been unsatisfactory. Mild stimulation with dionin or by massage with mercuric oxide may be tried. Optical iridectomy or keratoplasty may be considered in the advanced stages. Various atypical cases are described. The author reports two cases of the granular or crumb-like form, in brothers. Drawings of the biomicroscopic view are presented. (References.)

John C. Long.

Ravin, L. E. **Interstitial keratitis as sign of congenital syphilis.** Ohio State Med. Jour., 1942, v. 38, Aug., p. 760.

The author presents two cases of congenital syphilis diagnosed only after the onset of interstitial keratitis, the other signs of congenital syphilis having been so slight that they were not noted in previous examinations. He stresses the need for serologic tests in all youngsters and young adults with severe eye symptoms and inflammation of the cornea.

Theodore M. Shapira.

Sanders, M., and Alexander, R. C. **Epidemic keratoconjunctivitis.** Jour. Exper. Med., 1943, v. 77, Jan. 1, pp. 77-95. (7 plates.) (See Section 5, Conjunctiva.)

Schwartz, F. O. **Treatment of herpetic and dendritic ulcers.** Amer. Jour. Ophth., 1943, v. 26, April. pp. 394-400. (12 case reports, references.)

Smith, J. W. **Ochronosis of the sclera and cornea complicating alkaptonuria.** Jour. Amer. Med. Assoc., 1942, v. 120, Dec. 19, p. 1282.

The author reports four cases of ocular ochronosis, bringing to 82 the total number reported in the literature. Alkaptonuria is a relatively common disease and signs of ochronosis may appear before the age of thirty years. The diagnostic triad is pigmentation of the ears and scleras, urine that darkens on exposure to air, and osteoarthritis. Pigment spots in the corneas superficially near the temporal and nasal limbus are a diagnostic slitlamp finding in advanced ochronosis. Scleral ochronosis develops gradually and may be one of the first signs. (4 case reports, 7 figures, discussion.)

George H. Stine.

Smoleroff, J. W. **Scleral disease in rheumatoid arthritis.** Arch. of Ophth., 1943, v. 29, Jan., pp. 98-108.

Inflammation of the sclera and of the episclera, the latter first called subconjunctivitis by Graefe, have long been known to be associated with diseases of the articular structures of the body. In 1938 Verhoeff and King presented a case of rheumatoid arthritis in which an eye was removed because of an inflammatory perforating scleral lesion (scleromalacia perforans). The author reports in detail three cases of scleral involvement without perforation: in one case both eyes were studied histologically. The pathologic changes of the scleral disease associated with rheumatoid arthritis appear to consist of multiple disseminate and discrete areas of focal necrosis together with an inflammatory reaction of a subacute type leading to formation of relatively large abscesses. These abscesses show no disposition to become vascularized or organized, but contrariwise, tend to become reduced to cavities containing formless débris or sequestra.

Whatever the primary cause of rheumatoid arthritis may be, it is probable that the scleral lesions and the subcutaneous nodules are similar in nature, and the characteristic pathologic process observed in the eye may be due to the peculiar nature of the avascular tissue (sclera) involved. (2 figures, 8 references.) Ralph W. Danielson.

Urrets Zavalía, A., and Obregón Oliva, R. **New considerations concerning chrysiasis of the cornea.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Nov., p. 619.

Ocular chrysiasis due to deposition of gold particles in the tissues of the eye, specially the corneal stroma, in

patients receiving therapy with gold salts, shows two distinct evolutionary stages. In the first, tiny and highly refringent crystals appear in the most anterior lamellae, beneath Bowman's membrane. These crystals are more numerous in the central portion and fade toward the periphery. They usually appear when the patient has received a total of from 1 to 2 grams of gold salts. They tend to disappear as soon as treatment is discontinued. In the second stage, the deposition of gold takes place in the posterior corneal lamellae and Descemet's membrane, and from this area it advances to invade the whole stroma. It is permanent in character and undergoes no alteration even long after treatment has been discontinued. Other tissues of the eye in which deposits of gold salts can be found are the iris, ciliary body, and choroid, but corneal chrysiasis is probably the best-known form of this condition because of its accessibility to slitlamp examination. The authors report the cases of two patients who had received therapy with gold salts for tuberculosis, and who developed the typical picture of corneal chrysiasis. Plinio Montalván.

Vázquez Barrière, A. **Preliminary report concerning a new orientation on the etiology and pathogenesis of keratoconus.** Arch. de Oft. de Buenos Aires, 1941, v. 16, Oct., p. 559.

The author reviews exhaustively the general etiology of keratoconus, and, on the basis of the fact that the visibility of the terminal nerves of the cornea is increased, believes that a nerve lesion, probably due to a filtrable virus, is the primary cause of the condition. The author refers to the virus infections involving the eye, such as herpes simplex, herpes zoster, and lymphogranuloma inguinalis, in which the corneal nerves show an appearance similar to that in keratoconus. Since of these three disease entities lymphogranuloma frequently shows monosymptomatic manifestations in certain organs, such as palmar retraction and induratio penis, the author carried out Frei skin tests in a series of 12 cases of keratoconus. He obtained a marked positive reaction in all of them. No previous history or manifestation of lymphogranuloma inguinalis was recorded in any of the cases.

Plinio Montalván.

7

UVEAL TRACT, SYMPATHETIC DISEASE, AND AQUEOUS HUMOR

Bender, M. B. **Eyelid closure reaction.** Arch. of Ophth., 1943, v. 29, March, pp. 435-440.

One of the normal reactions seldom tested is the eyelid-closure reaction. Also known as the orbicularis reflex, this reaction is actually an associated movement. It consists of a constriction of the pupil in conjunction with active contraction of the orbicularis oculi muscle and upward rolling of the eyeball. The reaction is elicited by asking the patient to shut his eyes tightly, and when the lids are forcibly held apart the examiner notices a slight constriction of the pupil. Four case reports are given, and experimental work and neurologic explanations are discussed. The author says that pupillary constriction occurs with strong lid closure even though the pupil does not react to light or in accommodation. The miosis associated with lid closure is not dependent on a cranial nerve mechanism so long as pupilloconstrictor nerve fibers are functioning. The probability is that the lid-closure reaction is an associated or pattern movement which is co-

ordinated in the brain stem. (References.) Ralph W. Danielson.

Brown, E. V. L., Irons, E. E., and Rosenthal, S. R. **Results of desensitization in tuberculous iritis.** Arch. of Ophth., 1942, v. 28, Dec., pp. 1028-1037; also Trans. Amer. Ophth. Soc., 1942, v. 40.

Laboratory workers exposed to the fumes from boiling saline suspensions of dead tubercle bacilli develop a febrile reaction and other symptoms. After prolonged exposure to the fumes the cutaneous reaction to tuberculin is decreased. Guinea-pigs sensitized with B.C.G. vaccine become less sensitive to tuberculin after repeated exposure to the fumes. The inhalation of fumes from a boiling suspension of tubercle bacilli was used to desensitize two patients with recurrent serous iritis of probable tuberculous origin. One patient so treated has been free of recurrence for 26 months and has shown a reduction in cutaneous sensitivity to tuberculin. The second patient was free of recurrence for 17 months and then developed a slight recurrence after a direct prolonged exposure of the eyes to the fumes. (3 charts.)

John C. Long.

Green, John. **Severe kerato-iritis due to brucellosis: successful treatment with brucella abortus vaccine**. Amer. Jour. Ophth., 1943, v. 26, May, pp. 491-498.

Hamilton, J. B. **Ocular complications in relapsing fever.** Brit. Jour. Ophth., 1943, v. 27, Feb., pp. 68-80.

Four cases of iridocyclitis in a group of nine cases of relapsing fever are reported. In only two of the four was the spirochete isolated. When ocular complications arise the febrile period has usually passed. Two of the four patients with uveitis had a general relapse following the onset of iridocyclitis. There was an average of four attacks of fever before the onset of uveitis. The percentage of iridocyclitis following relapsing fever is estimated at twenty. Unlike syphilitic uveitis, the prognosis of relapsing-fever uveitis is extremely good. Heat and mydriatics only are required. (References.)

Edna M. Reynolds.

Kinsey, V. E., and Grant, W. M. **Further chemical studies in blood-aqueous humor dynamics.** Jour. Gen. Physiology, 1942, v. 26, Nov. 20, pp. 119-129.

Previous studies by the authors indicate that the rate of water movement into the anterior chamber of the eye is independent of the rate of movement of the electrolytes; that is, the aqueous humor is not formed as a whole, but represents a summation of a series of separate equilibria. The present studies have the following objectives: (1) to determine the rate of accumulation of various other substances in the anterior chamber from the blood; (2) to establish where possible the rate of transfer of the materials tested from the blood to the anterior chamber; (3) to determine which mathematical concept, namely ultrafiltration or secretion, of blood-aqueous fluid dynamics is best fitted by the experimental findings.

The first part of the report (this paper) is limited to the experimental work. The rate of accumulation following introduction into the blood of the following substances has been investigated: SCN, Br, Li, PO_4, urea, levulose, Mg, and Fe. Methods are described in detail and are illustrated by graphs. Rabbits were used for all the experiments. In a summary of the ex-

perimental work it is stated that the proportion of SCN, Br, PO_4, urea, levulose, and Fe which remains freely diffusible when added to plasma has been determined by ultrafiltration and "differential" dialysis through a cellophane membrane.

Jerome B. Thomas.

Kinsey, V. E., and Grant, W. M. **The mechanism of aqueous-humor formation inferred from chemical studies on blood-aqueous humor dynamics.** Jour. Gen. Physiology, 1942, v. 26, Nov. 20, pp. 131-149.

This, the second part of the report, analyzes experimental data based on a mathematical representation of several possible mechanisms of blood-aqueous dynamics. One of the outstanding problems of ocular physiology concerns the question whether the aqueous humor is formed by ultrafiltration (dialyzation) or by a secretory process.

The authors point out that for any substance entering the anterior chamber by an ultrafiltration process, an exchange of molecules between aqueous humor and plasma would be simultaneously operative and no net loss would result from such a process. Reports quoted from the literature support the idea that constituents of the aqueous humor may leave the anterior chamber by means of a through and through circulation. The authors state that evidence in favor of the secretory hypothesis has been largely negative, in that it has been based on the erroneous assumption that equilibrium ratios below 1. could not be accounted for except on the basis of a secretory hypothesis. On the other hand it is noted that Friedenwald and Stiehler have found that the epithelium of the ciliary body exhibits a selective permeability to basic and acid dyes; also that the mechanism for ion transport is one of oxidation and reduction. If one accepts the mechanism for ion transfer by secretion as propounded by Friedenwald (and the authors are aware of no other) it would appear that it is the cation which is actively secreted into the anterior chamber and that the anion is transferred as a result of electrical attraction. The transfer of noncharged substances would presumably occur by means of simple filtration. Suggestive of this is the penetration of neutral dyes through the stromal-epithelium barrier of the ciliary body as shown by Friedenwald.

The substantial agreement of all the experimental data with an assumed rate of leakage out of the anterior chamber of approximately 4 c.mm. per minute was shown to be compatible only with the idea that all the monovalent electrolytes tested entered the anterior chamber as a result of a secretory process. From these chemical studies it could not be decided whether the nonelectrolytes and the one multivalent electrolyte tested enter the anterior chamber by ultrafiltration or by secretion.

The application of the mechanisms outlined in this paper to the problem of intraocular pressure and its relation to glaucoma will be discussed in a later paper. Jerome B. Thomas.

8

GLAUCOMA AND OCULAR TENSION

Kinsey, V. E., and Grant, W. M. **Further chemical studies in blood-aqueous humor dynamics.** Jour. Gen. Physiology, 1942, v. 26, Nov. 20, pp. 119-129. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

Kinsey, V. E., and Grant, W. M. **The mechanism of aqueous-humor formation inferred from chemical studies on blood-aqueous humor dynamics.** Jour. Gen. Physiology, 1942, v. 26, Nov. 20, pp. 131-149. (See Section 7, Uveal tract, sympathetic disease, and aqueous humor.)

McKee, T. L. **Juvenile glaucoma.** The Military Surg., 1943, v. 92, Jan., p. 50.

Juvenile glaucoma of the left eye in a soldier aged twenty years is reported. Accompanying the report is a rather brief résumé of what is known about the disease. F. M. Crage.

9

CRYSTALLINE LENS

Gifford, S. R. **Lens extraction following filtering operations for glaucoma.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 468-473. (One illustration, references.)

O'Brien, C. S. **Comparison of the keratome-scissors and Graefe-knife incisions for cataract extraction.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 508-510. (2 tables.)

Regan, J. J. **Venesection in a case of choroidal hemorrhage following cataract extraction.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 534-536. (References.)

Roper, K. L. **Lancaster's technique of cataract extraction.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 540-550. (6 illustrations, references.)

10

RETINA AND VITREOUS

Cordes, F. C., and Dickson, O. C. **Angiomatosis retinae (von Hippel's disease). Results following irradiation of three eyes.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 454-463. (4 illustrations, 1 table, references.)

Gradle, H. S. **Concerning detachment of the retina.** Amer. Jour. Ophth., 1943, v. 26, May, pp. 524-527.

Gutmann, Adolf. **Pressure in central artery of retina in allergy.** Arch. of Ophth., 1943, v. 29, March, pp. 457-460.

Bailliart, Magitot, and others have found an increase in the pressure in the central artery of the retina in various eye conditions. Gutmann examined ten patients suffering from allergy, and found not only increased blood pressure in the humeral artery, but also that eight of the ten patients had in the central artery of the retina a systolic pressure greater than 100 mm. of mercury.

Experimentally the author then sensitized five rabbits with horse serum injected into the marginal vein of the ear. The retinal systolic pressure before the injections averaged 62 mm.; 14 to 28 days afterward it was as high as 110 mm. in one rabbit and the lowest was 71 mm. No mention is made of any generalized manifestation of sensitization in the rabbits. (One illustration, references.)

Ralph W. Danielson.

NEWS ITEMS

Edited by Dr. Ralph H. Miller
803 Carew Tower, Cincinnati

News items should reach the editor by the twelfth of the month

Deaths

Dr. W. Holbrook Lowell, Boston, Massachusetts, died March 31, 1943, aged 67 years.

Dr. Frank N. Emmert, Chambersburg, Pennsylvania, died March 15, 1943, aged 69 years.

Dr. Edwin Arnold Hyatt, St. Albans, Vermont, died February 14, 1943, aged 67 years.

Dr. Hale E. Cullom, Nashville, Tennessee, died April 30, 1943, aged 39 years.

Dr. Marcus P. Hambleton, Fontana, California, died March 16, 1943, aged 63 years.

Dr. Thomas F. Kennedy, Woonsocket, Rhode Island, died March 10, 1943, aged 68 years.

Dr. James Birckhead, Schenectady, New York, died March 16, 1943, aged 69 years.

Dr. James O. Carson, Bowling Green, Kentucky, died March 15, 1943, aged 87 years.

Dr. Jeremiah J. Cohane, New Haven, Connecticut, died March 9, 1943, aged 67 years.

Dr. Ernest B. McAndrew, Corning, New York, died March 15, 1943, aged 47 years.

Dr. Thomas P. Miller, Knoxville, Tennessee, died March 11, 1943, aged 65 years.

Dr. Jackson M. Mills, New York, New York, died March 17, 1943, aged 78 years.

Dr. Robert B. Rhett, Charleston, South Carolina, died March 23, 1943, aged 52 years.

Dr. John F. Rickenbach, Pittsburgh, Pennsylvania, died March 19, 1943, aged 94 years.

Dr. Charles W. Simison, Hawley, Minnesota, died March 6, 1943, aged 64 years.

Dr. Charles W. Stevens, New York, New York, died March 15, 1943, aged 75 years.

Dr. Villiers J. Webber, Fairhope, Alabama, died March 8, 1943, aged 64 years.

Dr. Philip R. Dwyer, Salem, Massachusetts, died February 28, 1943, aged 49 years.

Miscellaneous

The council of the American Academy of Ophthalmology and Otolaryngology has authorized the establishment of a memorial to the late Dr. William P. Wherry, Omaha, for many years secretary-treasurer of the organization.

The Teachers College, Columbia University, announced the opening of its Rehabilitation Service Center for the summer on July 5th. Short, intensive periods of training are being offered, including work in special-disability areas, such as the orthopedic, the blind, and the deaf, and consisting of practical instruction, demonstration, and application.

The Department of Ophthalmology of The College of Medicine of New York University announces that because of the educational program associated with the war effort, the Nine-Months' Graduate Course in Ophthalmology will be discontinued for the duration of the war.

Societies

The twenty-second meeting of the Reading Eye, Ear, Nose, and Throat Society was a joint meeting with the Reading Dental Society. The guest speaker, Dr. Oscar B. Batson, professor of anatomy of the Graduate School of Medicine, University of Pennsylvania, and assistant professor of otolaryngology of the Medical School, University of Pennsylvania, lectured on "Maxillo-facial emergencies."

Personals

Lt. Commander Arno E. Town, formerly of New York City, was the guest speaker at the May meeting of the Cleveland Ophthalmological Club. His subject was "Contact lenses."

At a recent meeting of the Board of Directors of the Academy of Medicine of Cleveland, Dr. M. Paul Motto, assistant clinical professor of ophthalmology, Western Reserve University School of Medicine, was elected president of the Academy. Dr. A. B. Bruner was elected vice-president.

Dr. J. Hewitt Judd has been made professor of ophthalmology and chairman of the department at the University of Nebraska. Dr. Harold Gifford has been appointed associate professor and Dr. W. Howard Morrison, assistant professor.